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How different is different? Investigating criteria for different identity judgments

Harold C. Hill
University of Wollongong, harry@uow.edu.au

Michelle Corcoran
mc374@uow.edu.au

Peter Claes

John Clement
The University Of Melbourne

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Abstract

Any face seen for the first time will have a closet neighbour in memory. In order to avoid false alarms, we must be able to distinguish similar from identical faces. Work is reported investigating same/different judgments as a function difference in three dimensional shape defined in terms of standard deviation in a principal component based face space. The aim is to determine the criterion difference below which observers respond “same”. A threshold corresponding to a dprime of 1 was also calculated. Both were first measured under three conditions – same view images, different view images and animated images of the faces rotating. Criterion did not differ significantly between presentation conditions and the mean criterion corresponded to 0.45 SD when the average face was used as the reference. Threshold did differ significantly between conditions, and was significantly higher for different view faces (.65SD) than for same view (.39SD) or animated faces (.44SD). The results are interpreted as indicating that the criterion for same/different judgements is relatively stable across presentation conditions, but that sensitivity is lower when making the judgement across a change in view. Further work will investigate whether criterion varies as a function of distinctiveness.

Keywords

different, judgments, investigating, criteria, identity

Disciplines

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Symposium in honour of the late Richard Gregory
Sunday
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ECVP 2010 Abstracts

Sunday

SYMPOSIUM IN HONOUR OF THE LATE RICHARD GREGORY

m Richard and randomness drove my research

S Anstis (University of California, San Diego (UCSD), USA; e-mail: sanstis@ucsd.edu)

In the mid-20th century, Richard was working on motion perception, so I, his first graduate student, did likewise. First, using a rotating kymograph drum, a xerox of Bela Julesz' first random-dot patterns, and a stroboscope, I failed to discover D_{max}. (Ol Braddick succeeded in discovering that later.) Then, using some fluorescent tubes driven by a home-made power pack, I failed to make a power stroboscope, but I stumbled across a ramp aftere_ect, which I published in Science. Encouraged, but only faintly, by Richard, I discovered reversed phi by putting the wrong slides into a projector. Inspired by Richard's declaring that my PhD. thesis was 'surprisingly good', I went on to stumble across the footsteps illusion, the chopsticks illusion, four-stroke cycle motion, crossover motion, zigzag motion; and I have been stumbling on ever since. Richard has helped me to demonstrate that fortune favours the prepared mind (Pasteur) and also the unprepared mind (Anstis). Thank you, Richard.

m All jazzy. Gregorian explorations of pure colour

P Cavanagh (Université Paris Descartes, France; e-mail: patrick@wjh.harvard.edu)

Like many of us, I was captured, enthralled, and enslaved by Richard Gregory the first time I heard him speak. He showed us how faces melt into indecipherable islands of colour when presented at 'isoluminance'. Inspired by Richard's flapping eyebrows, his big smile and a laugh that boasted of the fun of vision research, I joined legions of others abandoning their plodding first careers and became a vision scientist. Richard had shown us how to use filters in front of a slide projector to adjust the red to green luminance and find the treasured 'Critical Zone' of equal luminance, where all turned to jelly,

uncovering after 60 years the pioneering Gestalt discoveries of perceptual losses and the slowing of motion. For Richard's Gregory Fest in Bristol, we built Big Chroma, the world's largest equiluminant display with real people walking through a world of pure colour like bugs through yellow molasses. It was—just as had Richard promised—magic. I will show Richard's first demonstrations of perception at 'isoluminance' using where possible his original equipment.

m The continuing story of colour, form, and motion

T Troscianko (University of Bristol, UK; e-mail: tom.troscianko@bristol.ac.uk)

The selection procedure for my first postdoc job, with Richard Gregory, consisted of Richard showing me the apparatus which he and Rama were using to show random-dot motion at isoluminance, and asking me what I thought of the experiment. I said it was great which, apparently, was the correct answer and I got the job—to work on auditory perception. Richard's paper with Rama was published in Nature (1978 Nature 275 55-56) and the e_ect (loss of motion at isoluminance) was compelling. However, nobody reading that paper could make the slightest sense of the numerical data and suspicious minds claimed that the e_ect was unproven. So I set about doing it 'properly' (ie slowly) and nine years later the e_ect was replicated and extended in my paper (1987 Vision Research 27 547-554). This showed that although form-from-motion is not supported by isoluminant displays, the same displays are very good at supporting the perception of (static) symmetry. This should have been the end of the story but a paper cropped up in Nature (1999 Nature 399 115-116) and claimed that colour does not support symmetry perception. I shall show data, from a study with Innes Cuthill, that this latest argument is nonsense and Richard showed me the right path. For that, and everything else, I thank him.

m A dissociation between perception and action unmasked by the hollow-face illusion

M A Goodale[1], G Króliczak[2], P Heard[3], R L Gregory[4] ([1]University of Western Ontario, Canada; [2]University of Oregon, USA; [3]University of the West of England, UK; [4]University of Bristol, UK; e-mail: mgoodale@uwo.ca)

Richard Gregory was fascinated with the hollow-face illusion, in which a hollow mask looks like a normal convex face. He often used this illusion to illustrate the influence of top-down processing on perception. During a long discussion over a co_ee in Budapest some years ago, Richard and I resolved to use the hollow-face illusion to unmask a possible dissociation between vision-for-perception and vision-for-action. Together with Priscilla Heard and Greg Króliczak, we carried out an experiment in which we contrasted perceptual judgments about the hollow face with fast actions directed at targets on the face. Participants estimated the positions of small targets placed on the actually hollow but apparently normal face and used their fingers to 'flick' the targets o_. Despite the presence of a compelling illusion of a normal face, the flicking movements were directed at the real, not the illusory locations of the targets. These results show that the same visual stimulus can have completely opposite e_ects on conscious perception and visual control of fast action.

m Virtual hollow masks

B Rogers (University of Oxford, UK; e-mail: bjr@psy.ox.ac.uk)

Experiments using hollow faces and other objects have shown that there is both a specific e_ect of face stimuli per se and a more general e_ect of convexity/concavity in the depth reversal of hollow objects (Hill and Johnston, 2007 Perception 36 199-223; Króliczak, Heard, Goodale, Gregory, 2006 Brain Research 1080 9-16). One problem of using hollow masks is that it is di_cult to manipulate the di_erent stimulus characteristics of the display independently. To overcome this problem, we have created virtual hollow masks where we can independently manipulate (i) the shading characteristics, (ii) the amount of parallax motion, and (iii) the binocular disparities. In addition, we can arrange for the parallax motion to be a consequence of either object rotation or observer translation. At a conceptual level, the use of virtual hollow masks allows us to consider the nature of the separate and sometimes contradictory sources of information that are available, rather than describing the input in terms of the 'real' or 'reversed' depth (Rogers, 2010 Perception 39 285-288). Our results reveal how important shading information is compared with binocular disparities (when these are put in conflict) as well as positive interactions between shading and parallax information.

m Simple eyes and brains

D Osorio (University of Sussex, UK; e-mail: D.Osorio@sussex.ac.uk)

Evolution and the eyes of simple animals, especially the scanning eye of the copepod Copilia fascinated Richard (Gregory et al, 1964 Nature 201 1166). Copilia has a single line of photoreceptors, which scan with regular movements. He speculated this operated as a raster like a TV camera and may represent an early stage in compound eye evolution. In conversation in a Paris bar at ECVP 1989 Adrian Horridge, Richard, and I speculated about the evolutionary origin of the Hassenstein–Reichardt motion detector, which is a classic in neural computation. As a result Richard asked for a chapter on 'Evolution of motion vision' for Vision and Visual Dysfunction (Osorio, 1991, in Vision and Visual Dysfunction volume 2, Eds J R Cronly-Dillon, R Gregory, Macmillan, pp 203-228). I soon realized that common ancestor of modern insects and crustaceans such as crabs—and probably of Copilia herself, which lived over 500 million years ago—must have had good compound eyes with complex visual systems, whose basic cellular organisation and computational function have since changed little. The true

ancestral forms are completely unknown, and contrary to Richard's intuition, reconstructing the evolution of neural mechanisms by looking for simple intermediates amongst living species seems hopeless. Contemporary simpler forms are usually derived from more complex ancestors, not intermediates preserved in phylogenetic amber. Eye and brain evolution nearly always regresses rather than advances in complexity.

m Retro-reflecting on Richard Gregory's experimental apparatus

P Heard (University of the West of England, UK; e-mail: priscilla.heard@uwe.ac.uk)

We hope to be able to recreate Richard as a convex talking hollow man last seen at the Oxford ECVP 1998 and describe the optical advantages of measuring the Café Wall Illusion, not with computer methods, but with creative use of tra_c sign technology.

The Perception Lecture

Sunday

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THE LECTURE

m From grandmother to Jennifer Aniston: A history of linking perception to single neurons

C Koch (Division of Biology, California Institute of Technology, Pasadena, USA;
e-mail: koch.christof@gmail.com)

Dedicated neurons that fire in response to very particular specific concepts, such as to a picture of grandma, have played a prominent role in theories that link brain mechanisms to conscious visual perception. While the omega neurons of Freud are conceptual precursors, the best known include bug-detector cells of Lettvin, Maturana, McCulloch & Pitts (1959), gnostic neurons of Konorski (1967) and the cardinal cells of Barlow (1972). In the monkey, Gross first described face-cells in IT cortex (Gross, Bender and Rocha-Miranda, 1971). In more recent years, a combination of patches of face cells in the monkey (Tsao et al, 2008) together with face-selective regions in the fusiform face area in humans by Kanwisher has done much to establish the existence of neuronal mechanisms specific to faces. In the last decades, Fried, Koch and their collaborators have described single neurons in the medial temporal lobe of patients that fire in a remarkably selective manner to di_erent images, text or spoken names of famous or familiar individuals and objects. These data supports a sparse, abstract, invariant and modality-independent representation in MTL, suggesting that the identity of familiar individuals or objects is encoded by a sparse and selective, grandmother-like, representation. Ongoing experiments demonstrate that subjects can voluntarily, rapidly, reliably and specifically control the firing activity of these neurons in their own brain using feedback.

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Monday

Talk session: Attention

Monday

TALK SESSION: ATTENTION

m Capturing the gaze is not capturing the mind

E B Lange, R Engbert (Dept of Psychology, University of Potsdam, Germany;
e-mail: elke.lange@uni-potsdam.de)

How is attentional allocation related to memory encoding and retrieval? Digits were presented visually at di_erent locations on the screen. Either the numeric identities (verbal task) or the spatial positions (spatial task) had to be recalled in serial order. Concurrently, a distractor flashed at one position and changed its position rarely throughout the experiment. The change of distractor position was related to a memory performance decrease in the spatial but not the verbal task. Eye movement recordings demonstrated that the gaze was captured in both tasks. The critical variable was not whether the gaze was captured, but how long attention was engaged with the irrelevant stimulus. Time to redirect attention depended on task (verbal vs spatial) and manipulations of target-distractor similarity. Attentional engagement was also reflected in the recall output: Distractor features (eg its position) intruded erroneously. But both, temporal dynamics of the gaze and related memory errors did not fully explain memory impairment, showing associations and dissociations between attentional allocation and memory performance.

m Contributions of general and scene-specific knowledge to gaze guidance in repeated search

M L Vo, J M Wolfe (Visual Attention Lab, Harvard Medical School, BWH, USA;
e-mail: mlvo@search.bwh.harvard.edu)

When we search for an object in a scene, attention is guided by general knowledge (forks tend to be near plates on tables) and scene-specific knowledge (that fork is over there). How do the contributions of general and scene-specific knowledge to guiding attention develop with increasing scene familiarity? We recorded eye movements while subjects repeatedly searched for 15 di_erent objects within the same scene. Interestingly, we found that search performance (behavioral localization RTs and eye movements) remained essentially constant despite increasing scene familiarity. Even prior incidental fixations on a subsequent target object did not improve search for that object. However, search was hundreds of milliseconds faster and eye movements more direct the second time that an object was designated as a target. Simply seeing or even fixating on an object in a scene does not appear to create su_cient scene-specific knowledge to guide search. We found beneficial e_ects of scene familiarity only when the object was the target of an earlier deliberate search. Thus, unless su_cient scene-specific knowledge

has developed, general knowledge seems to continue to guide attention during repeated search.

m Are holes objects?

T S Horowitz[1,2], Y I Kuzmova[1] ([1]Visual Attention Laboratory, Brigham and Women's Hospital, USA; [2]Dept of Ophthalmology, Harvard Medical School, USA; e-mail: toddh@search.bwh.harvard.edu)

The evidence is mixed as to whether the visual system treats objects and holes di_erently. We used a multiple object tracking task to test the hypothesis that objects are easier to track than holes. Observers tracked four of eight items (holes or objects). We used an adaptive algorithm to estimate the speed allowing 75% tracking accuracy. In Experiments 1–2, backgrounds were photographic scenes. Objects were disks, holes were circular apertures through opaque surfaces. In Experiment 1 (N=12), disks and surfaces had the average background RGB values. In Experiment 2 (N=8) they were black against light backgrounds and dark against light backgrounds. Holes were easier to track than objects (Experiment 1: p=0.006, Experiment 2: p=0.040). Perhaps observers were distracted by the scenes, which were more visible in the object conditions. In Experiment 3 (N=10), we converted the background scenes into Portilla-Simoncelli textures. Consistent with the distraction hypothesis, performance was equivalent for holes and objects (p=0.328), and closer to performance for holes than objects in Experiments 1–2. It seems that objects and holes are equivalent for tracking purposes.

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m Ocularity as a basic visual feature dimension for bottom-up attentional attraction

L Zhaoping (Dept of Computer Science, University College London, UK; e-mail: z.li@ucl.ac.uk)

Color, motion direction, and orientation are incontrovertible basic feature dimensions, since dimensional singletons, eg a red item among green ones, attract attention automatically. The ocularity dimension is defined as the signed di_erence in input strengths from left and right eyes associated with an item.

I recently showed that eye-of-origin singletons, which are ocularity extrema, eg an item shown to the left eye among many items to the right eye, capture attention automatically, indeed more strongly than an orientation singleton with orientation contrast 50° [Zhaoping, 2008 Journal of Vision 8(5):1, 1-18]. This suggests that ocularity is a strong basic feature dimension, hitherto overlooked because of its transparency to awareness. Here, I report that ocularity singletons of all sorts, ie, items with unique ocularities among background items of uniform ocularity, also attract attention, as manifested by their exogenous cueing e_ect, eg a di_cult visual search becomes easier when the target is also an ocular singleton. In particular, a unique monocular item pops out among binocular ones, or a unique binocular item among those shown to a single eye. Further, as the only item with unbalanced inputs to the two eyes, an ocular singleton that is neither nearest nor farthest in depth, can pop out from background items at various depths.

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m Top-down dimensional set modulates feedforward visual processing: Evidence from the PCN component

T Töllner[1], H J Müller[1,2] ([1]Dept of Psychology, Ludwig-Maximilians-University Munich, Germany; [2]Dept of Psychological Sciences, Birkbeck College London, UK; e-mail: toellner@psy.uni-muenchen.de)

There is a general consensus that the detection of feature singletons is determined by the dynamic interplay of two distinct types of attentional control mechanisms: expectancy-driven (top-down) and stimulus-driven (bottom-up) control. This functional distinction is widely accepted and builds the basis for recent theories modelling visual attention (eg Wolfe, 1994 Psychonomic Bulletin & Review 1 202-238). However, the assumption that bottom-up processing may be influenced by top-down knowledge has recently been put into question by the 'stimulus-driven account' (Theeuwes, in press Acta Psychologica), according to which the initial feedforward sweep through the brain is cognitively impenetrable. To test this strong view regarding the penetrability of preattentive vision, we analyzed the PCN component (indexing preattentive processing speed) in combination with RT performance in two visual compound search tasks, in which the target was either preceded by a semantic word cue (dimension-cueing task), or presented simultaneously with a more salient distracter singleton (additional-singleton task). We found speeded RTs associated with shorter PCN latencies when the target was validly cued, or when the additional distracter was more likely to occur. This set of findings clearly demonstrates that preknowledge regarding nonspatial features and experience with distracter singletons can alter the initial selection priority and, thus, improve visual search.

m Measuring the filters for selective attention

G Sperling, S A Drew, C Chubb (Dept of Cognitive Sciences, University of California, Irvine, USA; e-mail: sperling@uci.edu)

How well can observers selectively attend in parallel to only a subset of stimulus items and ignore the remainder? Eleven observers judged the centroids (centers of mass) of briefly flashed clouds of 8–16 dots varying in contrast from dark black to bright white on a neutral gray background. Observers attended either only to dots darker than the background, only to dots lighter than the background, or to

all dots equally. The results are accounted for by a minimal model that assumes (1) a filter assigns a weight to each stimulus dot that depends only on the dot's contrast, (2) observers' imperfect centroid computations may overweight or underweight central versus peripheral dots, (3) centroid computations are perturbed by internal noise. Observers succeeded surprisingly well in these tasks, and individual observers' perceptual filters for attentionally selecting shades of gray were quantitatively determined. Attended dots typically had 4× the weight of unattended dots in the centroid computation. Accounting for the main results required only two attention filters, one preferentially sensitive to contrasts darker than the background, another to contrasts lighter than the background; the combination of both attention filters was used when attending to all the dots.

m Peripheral cues do not alter appearance: Bad performance leads to large cueing e_ects

D Kerzel, L Zarian, A Gauch, S Buetti (Faculté de Psychologie et de Sciences de l'Éducatiion, Université de Genève, Switzerland; e-mail: dirk.kerzel@unige.ch)

In a previous study (Carrasco et al, 2004), observers selected one of two Gabors that appeared to have higher contrast (spatial selection task). A peripheral cue preceded one of the Gabors by 120 ms. Results showed that the cue increased the perceived contrast of the adjacent Gabor. We examined the alternative

hypothesis that the cue biased observers to select the cued stimulus, without any changes in perception. We replicated the spatial selection task and found correlations between the precision of judgments and perceptual cueing e_ects. Observers who saw less di_erence between the stimuli showed larger cueing e_ects. Further, we changed the task and asked observers to judge whether the two Gabors were same or di_erent, which avoids spatial selection. Cueing e_ects were absent with equality judgments and trained observers, but present for untrained observers with poor ability to discriminate the stimuli. In another experiment, we showed that when observers' responses became more rapid over the course of the experiment, a cueing e_ect in brightness perception emerged that is unlikely to reflect perceptual changes. Overall, the results support the hypothesis that e_ects of peripheral cues on perceived contrast result from biased guessing. The more guessing there is, the larger the cueing e_ects.

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m Distinct e_ects of reward on attentional learning: from passive associations to active monitoring

C Della Libera, A Perlato, L Chelazzi (Dept of Neurological and Vision Sciences, University of Verona, Italy; e-mail: chiara.dellalibera@univr.it)

Visual Selective Attention (VSA) allows privileged processing of relevant inputs while filtering out distracting information. Recent findings suggest that the working of VSA may be shaped according to past outcomes. Targets whose selection led to rewarding outcomes become easier to select in the future, while distracters that have been ignored with better results are more easily discarded. Although in all these cases outcomes (variable monetary rewards) were completely predetermined, subjects were told that they were proportional to task performance, so that more e_cient responses would lead to higher gains. To investigate the nature of these e_ects, in a new experiment we have removed the illusory 'causal' link between performance e_ciency and outcomes by informing subjects that reward gains were delivered randomly. This simple yet crucial manipulation led to a remarkably di_erent e_ect on attentional deployment. Items that were followed more frequently by higher gains became more di_cult to ignore, regardless of their role (target or distracter) in the initially rewarded trials. Thus VSA may be sensitive to two distinct reward-related learning mechanisms: one requiring active monitoring of performance and outcome, and a second one detecting the association between the objects in the environment and the more-or-less rewarding events that accompany them.

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TALK SESSION: ADAPTATION, BRIGHTNESS AND CONTRAST

m Summation and suppression of luminance contrast across eyes, space, time and orientation: The equation of the visual brain

T S Meese, D H Baker (School of Life & Health Sciences, Aston University, UK; e-mail: t.s.meese@aston.ac.uk)

To understand summation of visual signals we also need to understand the opposite process: suppression. To investigate both processes we measured triplets of dipper functions for targets and pedestals involving interdigitated stimulus pairs (A, B) within each domain of interest (task: detect A on A; A on A+B; A+B on A+B). Previous work showed that summation and suppression operate over the full contrast range for the domains of ocularity (A and B are left and right eyes) and space (A and B are adjacent neighbourhoods). Here we include orientation and time domains and a contrast-matching task. Temporal stimuli were 15 Hz counterphase sine-wave gratings, where A, B were the positive and negative phases of the oscillation. For orientation, we used orthogonally oriented contrast patches (A, B) whose sum was an isotropic di_erence-of-Gaussians. Results from all four domains could be understood within a common framework: summation operates independently within the excitatory and suppressive pathways of a contrast gain control equation. Subtle di_erences across conditions were explained by variable strengths of divisive suppression. For example, contrast-matching confirmed that A+B has greater perceived contrast than A in the orientation domain but not the spatial domain, suggesting cross-orientation

suppression is weaker than spatial suppression.
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Talk session: Adaptation, brightness and contrast
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m 'Dilution masking', negative d-prime and nonmonotonic psychometric functions for eyes, space and time

D H Baker, T S Meese, M A Georgeson (School of Life & Health Sciences, Aston University, UK; e-mail: d.h.baker1@aston.ac.uk)

Recent work investigated contrast-interactions using targets and pedestals constructed from stimulus pairs (A, B) that were interdigitated across the domain of interest. It suggested similar gain-control frameworks for summation and suppression of contrast in the domains of space, time, ocularity and orientation. One of the properties of this framework is 'dilution masking'. This is di_erent from each of the well-known processes of 'within-channel' and 'cross-channel' masking and it derives from the integration of relevant target and pedestal regions (A) with uninformative pedestal regions (B). It makes a surprising prediction when the pedestal contrast in the target region (A) is reduced to 0%. If suppression between A and B is strong, the model's contrast-response first decreases for small target contrast-increments before increasing to threshold as target contrast approaches the high mask contrast. This predicts a nonmonotonic psychometric function, where discrimination performance drops below 50% correct in 2AFC, implying negative d..We have confirmed the existence of this paradoxical 'trough' empirically in contrast-masking experiments for interdigitated (A, B) stimuli in each of three stimulus domains: space, time (flicker) and ocularity. But in the orientation domain, where cross-orientation suppression is relatively weak, the e_ect is not found, consistent with the gain-control model.

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m Visual awareness a_ects only the indirect tilt illusion, not its direct counterpart

A Tomassini, J A Solomon (Optometry & Visual Science, City University of London, UK; e-mail: alessandro.tomassini.1@city.ac.uk)

A classic example of contextual influence is the illusion of tilt exerted on a vertical target by an oriented surround. It has been suggested that the shape of the tilt illusion's angular function is due to the addition of a low-level repulsive process (ie the direct e_ect) to a higher level attractive process (ie the indirect e_ect). This model predicts that only direct e_ects should be elicited by post-adaptation invisible surrounds, as high level processes require awareness. We tested this prediction by measuring the orientation biases of a parafoveally presented, Gabor patch surrounded by an oriented grating after 20 s of dynamic adaptation. The adapting stimulus was an annularly windowed plaid composed of a vertical and horizontal jittering gratings. Observers were instructed to maintain fixation throughout the trial and report whether the Gabor appeared to be tilted clockwise or anticlockwise of vertical. They also had to indicate whether the surround was visible after adaptation. The results show that near-vertical surrounds produced repulsive biases, but no attractive e_ects were produced by horizontal ones. This supports the idea that direct e_ects are low-level (ie V1) phenomena whereas indirect e_ects take place at higher (ie extrastriate) levels.

[Supported by EPSRC grant #EP/E064604]

m The direct tilt aftere_ect can increase with test duration: evidence for the active role of the test

V Lefebvre, K Langley (Division of Psychology and Language Sciences, University College of London, UK; e-mail: v.lefebvre@ucl.ac.uk)

The direct tilt aftere_ect (DTAE) is an optical illusion resulting in a bias in perceived orientation, elicited by adapting to a 1D tilted pattern while testing with a similar pattern at a nearby orientation. DTAEs typically decay as a function of the duration of the test pattern. Using established psychophysical methods, we adapted to flickering (0–50 Hz) 2.0 cpd sinusoidal gratings (15 s plus 2.5 s top-up) and tested with similar gratings whose orientation di_erence from the adaptor was fixed at 15 degrees. At the lower test temporal frequencies (TFs) we show that the magnitude of DTAEs declined as a function of the duration of the test, but this was not so at the higher test TFs, where the magnitude of DTAEs was found to increase with the test durations over 0.1–0.5 s. The high TF increases in DTAE as a function of test duration are reported to be inversely dependent upon both the screen luminance and/or the test contrast which both shorten the build up phase of the DTAEs. Our main e_ects also transfer interocularly albeit with a smaller magnitude. The TAE thus results from an active integration of the adaptation level and the test e_ect.

[Supported by EP/E030793/1]
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Monday
Talk session: Adaptation, brightness and contrast

m Attention and the motion aftere_ect

M J Morgan (Max Planck Institute of Neurology, Cologne, Germany; e-mail: m.morgan@city.ac.uk)

Despite the failure of Wohlgemuth (1911) to find an e_ect of attention on the motion aftere_ect, several later studies have reported that the magnitude of the e_ect is reduced if observers' attention is distracted

from the adapting stimulus. Most of these studies have used the duration measure of the MAE, which has been shown to be highly susceptible to observer expectation and bias. A series of experiments will be described using di_erent measures of motion adaptation, including duration, cancellation, balance point of a counterphasing grating, and contrast sensitivity, none of which succeeded in finding an a_ect of 'attentional load' of a foveal task upon adaptation to a parafoveal adaptor. Attention to one component of a transparently moving stimulus, did produce an e_ect, but it was small and variable between observers. The currently popular belief that attention can a_ect processing in primary visual cortex is not supported by these data, even if it is true on other grounds.
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m Does the visual system encode luminance ratios? Depth-lightness experiment reveals dramatic rescaling of relative luminance

A L Gilchrist, A Radonjic (Dept of Psychology, Rutgers University, USA;
e-mail: alan@psychology.rutgers.edu)

The assumption that the visual system encodes luminance ratios at borders rather than absolute pointwise luminance values has been widely assumed for 50 years. We now report strong evidence against this assumption. We replicated Gilchrist's 1977 experiment on depth and lightness using a low overall luminance range (30:1) but high articulation in each plane. Stimulus: two perpendicular Mondrians, equally illuminated, one containing 20 light gray patches (middle gray to white), the other containing 20 dark gray patches (middle gray to black). As a middle gray target tab extending from the corner shifted in apparent position from one plane (monocular viewing) to the other (binocular viewing), its perceived reflectance shifted by a factor of 7:1, exceeding the 5:1 simulated illumination range (a surprising over-constancy) and equaling Gilchrist's depth e_ect obtained using a 900:1 luminance range. The 5:1 luminance range within each plane was perceived as almost a 30:1 range of reflectances. This suggests the illumination di_erence across planes was perceptually expanded as well (restoring the expected under-constancy). Related work shows that a 500:1 range of luminances can be perceived as a 30:1 range of reflectances. These examples of dramatic rescaling seriously undermine the assumption of ratio encoding and challenge every current theory of lightness.
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m Real world lightness constancy is bad (and why), but perfectly matched to language and memory

R J Baddeley, D Attewell, S Patel (Experimental Psychology, Bristol University, UK;
e-mail: roland.baddeley@bristol.ac.uk)

Determining the physical properties of objects is one of the most important tasks of vision, and the simplest physical property of an object is its reflectance. Our ability to extract this (lightness constancy), under typical experimental situations has been found to be very good. In contrast, our memory and language for reflectance/lightness has a very low information capacity (0.8–1.5 bits). This implies that either the brain makes accurate measurements, and then throws information away, or artificial experiments on lightness constancy have over estimated our real world ability. Three reasons for such an over estimate are : (1) inappropriate anchoring noise; (2) inappropriately simple geometry; and most importantly, (3) inappropriately simple lighting environments. We therefore tested participant's ability to match reflectance standards placed in a local forest using a method that avoided these confounds. We found performance was very poor (less than one bit), but perfectly matched the information capacity of memory and language. We then show using a novel optical technique that this is due to the complexity of real world illuminants. We conclude that real world lightness constancy is bad (providing less than one bit of information), but perfectly matched to out memory and language.

m Does the luminance range of a framework play a role in lightness computations?

E Economou (Psychology Dept, School of Social Sciences, University of Crete, Greece;
e-mail: elias@psy.soc.uoc.gr)

Purpose: According to anchoring theory (Gilchrist et al, 1999), surface lightness results from computations in several perceptual groups (frameworks) to which the surface belongs. Each of these

computations has a variable weight, which depends on the perceptual coherence of the framework and the lightness statistics that it contains. We tested the hypothesis that the luminance range of a framework is positively correlated with its computational weight. Method: We measured the strength of the simultaneous lightness contrast illusion in several displays where the local (target and its immediate background) and/or the global (whole display) luminance range was varied. Ten observers matched the lightness of the targets in each display. Results: The results seem to suggest that luminance range plays a role in determining the weight of each framework's lightness computations. Additionally the results might o_er an explanation for the data discrepancy that has been observed in studies using simultaneous lightness contrast displays with incremental targets [Gilchrist, 1988 P&P 43 415-424; Agostini and Bruno, 1996 P&P 58 250-258; Rudd and Zemach, 2005 JoV 5(11):5, 983-1003; Bressan and Actis-Grosso, 2006 Perception 35 445-452; Economou et al, 2007 JoV 7(12):2 1-15; Blakeslee et al, 2009 JoV 9(3):22, 1-17].

SYMPOSIUM: FACE PERCEPTION IN MAN AND MONKEY

m Let's face it: It's a cortical network
A Ishai (Institute of Neuroradiology, Zurich University, Switzerland; e-mail: ishai@hifo.uzh.ch)
The recognition of facial identity is based on invariant facial features, whereas changeable aspects of the face, such as speech-related movement and expression, contribute to social communication. Processing the information gleaned from the faces of others requires the integration of activation within a network of cortical regions. We have shown that faces evoke activation within distributed neural system in the human brain that includes visual ('core'), limbic and prefrontal ('extended') regions. The core system includes the inferior occipital gyrus and lateral fusiform gyrus (FG), extrastriate regions that process the identification of individuals and the superior temporal sulcus, where gaze direction and speech-related movements are processed. The extended system includes the amygdala and insula, where facial expressions are processed, the inferior frontal gyrus, where semantic aspects are processed, and regions of the reward circuitry, including the nucleus accumbens and orbitofrontal cortex (OFC), where facial beauty and sexual relevance are assessed. Analysis of e_ective connectivity reveals that the major entry node in the 'face network' is the FG and that the functional coupling between the core and the extended systems is content-dependent. Viewing emotional faces increases the neural coupling between the FG and the amygdala, whereas viewing famous faces results in increased e_ective connectivity between the FG and the OFC. A model for face perception is proposed, which postulates bidirectional connections between all face-responsive regions and further assumes that the flow of information through the network is stimulus- and task-dependent, and several new testable predictions are suggested. These findings suggest that face perception is not a mere 'bottom-up' feature analysis, but rather, a dynamic process that is 'top-down' modulated by task demands and cognitive processes such as memory, emotion and sexual preference.

m Structural white-matter connectivity between face responsive regions in the human brain
P Vuilleumier[1,2], G Pourtois[3], S Schwartz[1,2], D Van De Ville[4,5], M Gschwindl[1,2] ([1]Laboratory for Behavioral Neurology & Imaging of Cognition, University of Geneva, Switzerland; [2]Dept of Neurology, University Hospital of Geneva, Switzerland; [3]Dept of Experimental Clinical and Health Psychology, Ghent University, Belgium; [4]Dept of Radiology and Medical Informatics, University of Geneva, Switzerland; [5]Institute of Bioengineering, École Polytechnique Fédérale de Lausanne (EPFL), Switzerland; e-mail: patrik.vuilleumier@unige.ch)
Although face recognition is thought to rely on a set of selective regions organized in a distributed functional network, the exact architecture of interconnections between these regions remains unknown. Current MRI techniques now allow us to map response profiles of functionally distinct cortical regions as well as their structural connectivity through white matter pathways in a non-invasive manner. This talk will illustrate how fMRI can be used to identify face-responsive regions in healthy individuals, and then be combined with di_usion tensor imaging (DTI) and probabilistic tractography to establish the white-matter interconnections between these functionally-defined regions. Our results demonstrate dense white-matter tracts between the occipital face area (OFA) and fusiform face area (FFA), with a significant right-hemisphere predominance. However, no evidence was found for direct anatomical connections of either FFA or OFA with superior temporal sulcus (STS). Instead, our findings suggest segregated processing along ventral extrastriate visual pathways to OFA-FFA and more dorsal pathways connected to STS. In addition, dense connections exist between occipital cortex and amygdala, which

might underlie a rapid recruitment of medial temporal limbic brain areas by visual inputs. These data show that combining functional and structural MRI approaches can provide new insights on the neural architecture of the human face recognition system and help clarify how distributed face-responsive areas may work together.

m Behavioral and fMRI evidence for a prolonged development of face recognition in children
G Golarai (Psychology Dept, Stanford University, USA; e-mail: ggolarai@stanford.edu)
Crucial for social interaction and communication, face processing begins in early infancy. However, decades of behavioral studies suggest a prolonged development of face recognition that continues well into adolescence. What are the neural mechanisms of face recognition development during childhood? Is this prolonged development specific to faces, or is it a byproduct of age related improvements in general cognitive and behavioral competence? Using functional magnetic resonance imaging (fMRI) along with behavioral studies, my research suggests that the face selective region in the fusiform gyrus (fusiform face area, FFA) undergoes a prolonged development after age 7 that continues well into adolescence. This development manifested as an increase in the volume of the FFA and its response amplitude and selectivity for faces, as well as increased di_erentiation of the distributed patterns of response to faces versus non-face stimuli in the ventral temporal cortex (VTC), regardless of the age of the face stimuli. Moreover, increased FFA volume was associated with improvements in recognition memory performance for faces, but not for objects or places. These findings suggest a specific and prolonged development of face-selectivity across the VTC during childhood and adolescence that may underlie the prolonged development of face recognition proficiency during childhood development. I will discuss the implications of these findings vis-á-vis the role of experience dependent neurophysiological mechanisms, and atypical development in neurogenetic conditions such as Williams syndrome.

m A comparative approach using fMRI to investigate the face perception network in humans and macaques

M A Pinsk, M Arcaro, S Kastner (Princeton Neuroscience Institute, Princeton University, USA; e-mail: mpinsk@princeton.edu)

Functional MRI evidence suggests that the human temporal cortex contains a number of areas selective for faces, each with a di_erent function to mediate face perception (Puce et al, 1995; Kanwisher et al, 1997; Haxby et al, 2000). Using electrophysiology, neurons responding selectively to faces have been found throughout the superior temporal sulcus (STS) and inferotemporal (IT) cortex of the macaque monkey. More recently, functional magnetic resonance imaging (fMRI) studies in awake macaques have revealed several areas along the STS with significantly stronger BOLD responses to faces compared to other object categories (Tsao et al, 2003; Pinsk et al, 2005; Hadj-Bouziane et al, 2008). It is unclear how these fMRI-defined face areas in the macaque STS correspond to those found in the human lateral and ventral temporal cortex. One approach to draw comparisons across species is to investigate the spatial locations of face areas with respect to retinotopically organized cortex and gross anatomical locations. We have mapped retinotopic and face-selective cortex in both species using identical stimuli, experimental paradigms, and data analysis methods. Our retinotopic maps of macaque and human visual extrastriate cortex show that posterior face areas in both species are adjacent to the visual motion complexes, and all lie anterior to visual area V4. Interestingly, the macaque face areas all fall within the vicinity of the STS, unlike the ventral temporal areas in the human. This direct comparative approach provides a basis for the speculation of corresponding face areas across species.

TALK SESSION: OBJECTS

m Closure is fundamental to object recognition

S B Rosen[1], R K Chakravarthi[2], D G Pelli[1] ([1]Psychology and Neural Science, New York University, USA; [2]Centre de Recherche Cerveau et Cognition, CNRS - Université Paul Sabatier, France; e-mail: sarahbr2@gmail.com)

The Gestalt law of closure is known to a_ect object detection but has never been studied in the context of object identification. Object identification requires not only feature detection but also feature combination. Feature combination goes awry when a target object is flanked by other objects. We exploit this vulnerability, called crowding, to expose the rules of object recognition. Here, we manipulate closure, proximity, and similarity in a crowding paradigm. Targets and flankers consist of jagged vertical bars connected by parallel horizontal bars. We disrupt closure by breaking each flanker in half, left and right, and inserting a gap. On the one hand, we find that breaking flanker closure dramatically reduces

crowding. Any disconnected features beyond a critical distance have no e_ect on target identification. On the other hand, imposing target-flanker closure, by connecting the target and the flankers with horizontal bars, greatly strengthens crowding. These e_ects occur regardless of similarity and proximity. We conclude that closure determines which features the visual system combines to recognize an object.

m Generalization between canonical and noncanonical views in object recognition

T Ghose[1,2], Z Liu[1] ([1]Dept of Psychology, UCLA, USA; [2]Dept of Psychology, TU Kaiserslautern, Germany; e-mail: tandraghose@yahoo.com)

We investigated the extent to which object-recognition can be generalized from canonical to noncanonical view, and vice-versa. The experiment had two sessions: One included basic-level objects, the other subordinate-level objects. Each session had two phases. In study phase, attractiveness of each common object was rated that was shown either from canonical or noncanonical view. In test phase, the likelihood of an object being seen in the study phase was rated. All studied (old) objects and same number of new objects were shown. Half of the objects were shown in canonical views, and half in noncanonical views. Half of old objects were shown identically as in study phase. No object was retested. Hit-rates were comparable and highest when study and test views were identical, regardless of canonicalness and session. Interestingly, when an old object's view was changed, drop in hit-rate from noncanonical-study view to canonical-test view was less than the other way around, in the subordinate-level session. In the basic-level session, these two drops were comparable and, as expected, smaller in magnitude than in the subordinate-level session. View-generalization in object-recognition appeared to be greater when an object was first learned from a nonclinical, and when subordinate-level shape details were important. This implies that in precise shape representation, a view was less likely to be stored as a snapshot template, but more likely to be regularized or 'canonicalized' in viewpoint-generalization.

m Optimizing minimal sketches of visual object categories

D Engel[1], V A Kottler[2], C U Malisi[3], M Röttig[4], S J Schultheiss[5], E M Willing[2], C Curio[1], H H Bülth_[1] ([1]Dept of Human Perception, Cognition and Action, Max Planck Institute for Biological Cybernetics, Tübingen, Germany; [2]Dept of Molecular Biology, Max Planck Institute for Developmental Biology, Germany; [3]Research Group Protein Design, Max Planck Institute for Developmental Biology, Germany; [4]Center for Bioinformatics, Eberhard-Karls-Universität Tübingen, Germany; [5]Machine Learning in Biology Research Group, Friedrich Miescher Laboratory of the MPS, Germany; e-mail: david.engel@tuebingen.mpg.de)

We present an iterative optimization scheme for obtaining minimal line sketches of object categories. Minimal sketches are introduced as a tool to derive the most important visual properties of a visual object category and can potentially provide useful constraints for automatic classification algorithms. We define the minimal sketch of an object category as the minimal number of straight lines necessary to lead to a correct recognition by 75% of naïve participants after one second of presentation. Nine participants produced sketches of 30 object categories. We displayed the three sketches with the lowest number of lines for each category to 24 participants who freely named them. In consecutive rounds the sketchers had to optimize their drawings independently based on sketches and responses of the previous rounds. The optimized sketches were subsequently rated again by 24 new subjects. The average number of lines used in the sketches decreased from 8.8 to 7.9 between the two trials while the average recognition rate increased from 57.3% to 67.9%. 27 of the 30 categories had at least one sketch that was recognized by more than 75% of subjects. For most of the categories, the sketches converged to an optimum within two drawing-rating rounds.

m Cross modal object based attention

L H de-Wit[1], R W Kentridge[2], A D Milner[2] ([1]Experimental Psychology, University of Leuven (KU Leuven), Belgium; [2]Dept of Psychology, University of Durham, UK; e-mail: lee.dewit@psy.kuleuven.be)

Whilst numerous studies provide evidence that attention can move in a spatial reference frame that is fundamentally crossmodal (Spence and Driver, 2004 Crossmodal Space and Crossmodal Attention OUP, Oxford), few studies have explored the extent to which more complicated reference frames (such as those provided by objects) can be shared across modalities in order to guide the allocation of attention. By examining the allocation of attention to LED targets presented on wooden objects that could be held but not seen, we provide evidence that visual object based attention e_ects (Egly et al, 1994 Journal of Experimental Psychology-General 123 161-177) can be elicited by objects that are perceived purely on the basis of tactile stimulation. This finding is consistent with recent fMRI evidence exploring the neural

overlap of activations elicited by both tactile and visual object perception (Amedi et al, 2007 Nature Neuroscience 4 324-330). Furthermore, our results help to constrain our understanding of where in the visual system object representations come to influence the allocation of attention, thus clarifying what exactly counts as an 'object' for attentional selection (Driver et al, 2001 Cognition 80 61-95).

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m Visual field representation in object-selective areas

A-K Schobert[1], J V Schwarzbach[1,2] ([1]Center for Mind/Brain Science, University of Trento, Italy; [2]Dept of Cognitive Science and Education, University of Trento, Italy; e-mail: anne.schobert@unitn.it)

The early stages of object perception have been characterized by a retinotopic representation of the visual field and by a low degree of object category selectivity. In contrast, high-level visual areas in the ventral stream have been shown to be highly selective for object category, but are considered to be largely insensitive to the location of objects (Konen and Kastner, 2008 Nature Neuroscience 11 224-231). Recently, this strict dichotomy has been questioned (Sayres and Grill-Spector, 2008 Journal of Neurophysiology 100 249-267). We used high-resolution fMRI and retinotopic mapping techniques with object stimuli and tested to which extent and detail spatial information is represented in the ventral stream. We found that within object-selective areas di_erent voxels are sensitive to di_erent positions of object stimuli, covering nearly the whole visual field. Our findings are in contrast with a classic model of the organization of visual cortex and refine more recent studies that showed that FFA and PPA are parts of a larger eccentricity map which spans the whole ventral cortex [Levy et al, 2001 Nature Neuroscience 4(5) 533-539]. Here we show that the underlying more detailed organization of FFA and PPA represents almost the entire visual field.

m Social interaction recognition and object recognition have di_erent entry levels

S de la Rosa[1], R Choudhery[1], H H Bülth_o[1,2] ([1]Dept of Human Perception, Cognition and Action, Max-Planck Institute for Biological Cybernetics, Tübingen, Germany; [2]Dept of Brain and Cognitive Engineering, Korea University, South Korea; e-mail: stephan.delarosa@gmail.com)

Objects can be recognized at di_erent levels of abstraction, eg basic-level (eg flower) and subordinate level (eg rose). The entry level refers to the abstraction level for which object recognition is fastest. For objects, this is typically the basic-level. Is the basic-level also the entry level for the social interaction recognition? We compared basic-level and subordinate recognition of objects and social interactions. Because social interaction abstraction levels are unknown, Experiment 1 determined basic-level and subordinate categories of objects and social interactions in a free grouping and naming experiment. We verified the adequacy of our method to identify abstraction levels by replicating previously reported object abstraction levels. Experiment 2 used the object and social interaction abstraction levels of Experiment 1 to examine the entry levels for social interaction and object recognition by means of recognition speed. Recognition speed was measured (reaction times, accuracy) for each combination of stimulus type and abstraction level separately. Subordinate recognition of social interactions was significantly faster than basic-level recognition while the results were reversed for objects. Because

entry levels are associated with faster recognition, the results indicate di_erent entry levels for object and social interaction recognition, namely the basic-level for objects and possibly the subordinate level for social interactions.

SYMPOSIUM: COLOUR APPEARANCE MECHANISMS

m Individual di_erences in trichromatic human colour vision

A D Logvinenko (Dept of Vision Sciences, Glasgow Caledonian University, UK;
e-mail: a.logvinenko@gcal.ac.uk)

Individual di_erences between the 49 Stiles & Burch (1959) observers were analysed by using the object-colour space by Logvinenko (2009). A set of rectangular reflectance spectra was used as a common frame reference for representing object colours for all the observers. These reflectance spectra, taking two values:i<k (0<k<0.5) or 1–k, with two transitions (from k to 1 – k) across the spectrum, are fully specified by the transition wavelengths, l and m, and the number k. Being metameric to one of these rectangular reflectance spectra, every reflectance spectrum can be geometrically represented as a point in the 3D unit-ball, longitude and latitude of which encoding the central wavelength [(l+m)/2] and spectral bandwidth (l– m), respectively, with the distance from the centre equal to 0.5+k. The inter-individual di_erences reveal themselves in that for various observers the same reflectance spectrum map to di_erent

points in the ball. The spherical distance between the two points produced by two observers for the same reflectance spectrum is taken as a measure of the inter-individual di_erence. It was evaluated for 1600 Munsell papers for all 49 observers [Logvinenko, 2009 Journal of Vision 9(11):5, 1-23].

m Colour appearance mechanisms are not a_ected by age-related sensitivity changes

S M Wuerger[1], C Fu[1], K Xiao[1], D Karatzas[2] ([1]School of Psychology, University of Liverpool, UK; [2]Computer Vision Centre, Universitat Autónoma de Barcelona, Spain;
e-mail: s.m.wuerger@liverpool.ac.uk)

Purpose: The purpose of this study was to assess in a large sample of colour-normal observers of a wide age group (N=185; age range: 18–75) whether age-related sensitivity changes are associated with corresponding changes in hue perception. We therefore obtained the following data in the same set of observers: thresholds along the protan, deutan and tritan line (using the Cambridge Colour Test), settings for the four unique hues (red, yellow, blue, green), and neutral grey settings. Results: We find a significant decrease in chromatic sensitivity with increasing age, in particular along the tritan line. Neither the unique hues nor the neutral grey settings change significantly with age. When we predict the hue settings based on the known age-related changes in the ocular media we find a pronounced dependency on age, which is at odds with the observed invariant hue settings. Conclusion: Chromatic discrimination sensitivity declines with age, whereas suprathreshold colour perception is constant. This is consistent with adaptive cone weightings of supra-threshold colour appearance mechanisms. Possible mechanisms underlying this colour constancy across the life span will be discussed.

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m Spatial and temporal adjustments to colour appearance

H E Smithson, R J Lee (Dept of Psychology, Durham University, UK;
e-mail: hannah.smithson@durham.ac.uk)

The appearance of coloured patches depends upon spatial and temporal context. To determine the relative contributions of the spatial surround and the temporal sequence of stimuli in setting colour classification boundaries [Smithson and Zaidi, 2004 Journal of Vision 4(9) 693-710] we manipulated the chromatic statistics of our stimuli. Test patches were drawn from two overlapping but displaced distributions in colour space. Multiple red-versus-green classifications were obtained for samples drawn from the two sets. In di_erent conditions the two sets were either interleaved at one retinal location ('interleaved') or presented at di_erent retinal locations ('separated'), and were presented against a background of patches coloured from either the union of the two sets ('combined') or from the set corresponding to the test patch ('consistent'). In the 'separated' conditions, classification boundaries shifted towards the local time-average of each set. For the 'consistent' surround, this shift was of similar magnitude to the di_erence in set-means whereas, for the 'combined' surround, it was much reduced. In the 'interleaved-combined' condition, classifications were dominated by the combined mean of the sets whereas, in the 'interleaved-consistent' condition, boundaries for the two sets were slightly displaced. The results suggest di_erent time-courses for adaptation and anchoring.

m Cultural knowledge influences colour appearance

C Witzel, H Valkova, T Hansen, K R Gegenfurtner (Experimental Psychology, Justus-Liebig-University Giessen, Germany; e-mail: Christoph.Witzel@psychol.uni-giessen.de)

We investigated the memory colour e_ect for colour-diagnostic artificial objects. Since the colours of these objects have been learned in a certain cultural context, these stimuli allow investigating the influence of cultural knowledge on colour appearance. These investigations are relevant for the question about the interaction of object and colour information in high-level vision as well as for research about the influence of learning and experience on perception in general. To identify useful artificial objects, we applied a reaction time paradigm to measure (subjective) colour-diagnosticity. Then, we let people

adjust sixteen such objects to their typical colour as well as to grey. If the achromatic object appears in its typical colour then participants should adjust it to the opponent colour in order to subjectively perceive it as grey. We found that knowledge about the typical colour influences the colour appearance of artificial objects. Moreover, the results showed that this e_ect is particularly strong along the daylight axis.

m Colour category boundary in bilinguals: In search of the Whorfian e_ects

G V Paramei, J Molyneux (Dept of Psychology, Liverpool Hope University, UK;
e-mail: parameg@hope.ac.uk)

In the colour domain, the Whorf hypothesis implies that language a_ects colour categorisation. We questioned whether in bilinguals colour category boundaries vary between languages. Three native Germans (L1) highly proficient in English (L2) were matched with English monolinguals. Eleven colours displayed on a CRT monitor spanned the range between Unique Blue and Unique Green. Colour was exposed for 160 ms, 20 times in left (LVF) and right visual field (RVF), in pseudorandom order. Following exposure, terms Blue and Green ('English session') or Blau and Grün ('German session'; bilinguals) appeared above and below the fixation point, randomly alternating their position. Observers indicated stimulus category by pressing the corresponding button. Response times (RTs) and term choices were collected. For each colour, left and right, mean RTs and frequency of Blue-(Blau-)naming were calculated. For bilinguals, responses were significantly faster in L1, indicating less automated processing for L2. The Blue-Green boundary was identical for LVF and RVF in German. Importantly, in English it was the same for RVF but di_ered for LVF. Also, in English RTs were shorter for the RVF. We conclude that in bilinguals the RVF Whorfian e_ect (Gilbert et al, 2006 PNAS 103 489-494) manifests itself in L2.

TALK SESSION: NEURAL MECHANISMS

m Perceptual decisions are based on the most informative sensory neurons

M Scolari[1], J T Serences[1,2] ([1]Dept of Psychology, University of California, San Diego, USA;
[2]Graduate Program in Neuroscience, University of California, San Diego, USA;
e-mail: mscolari@ucsd.edu)

Single-unit studies often indicate that perceptual decision-making is based on the output of sensory neurons maximally responsive (or 'tuned') to relevant stimulus features. However, when performing a discrimination between two highly similar stimuli, perceptual decisions should instead be based on the activity of neurons tuned away from the relevant feature (o_-channel neurons). For example, when discriminating a 90° oriented line from a set of distractors rotated to 92°, neurons tuned to flanking orientations will be most informative given that they undergo a larger firing rate change in response to the target and distractors. We measured feature-selective responses in human primary visual cortex (V1) using fMRI while subjects completed a 2AFC task in which they indicated the direction of a small rotational change between a sample and test grating. The degree of o_-channel activation predicts performance on this di_cult visual discrimination task. Given that the reference orientation di_ered on each trial, this predictive relationship is not simply the result of extensive practice with a specific stimulus feature (as in studies of perceptual learning). Instead, relying on the relative change in activity of the most informative sensory neurons may represent an optimal strategy for e_ciently making perceptual decisions.

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m Manipulating visual perception with real-time fMRI-based neurofeedback training

F Scharnowski[1,2], C Hutton[1], O Josephs[1], N Weiskopf[1], G Rees[1,2] ([1]Wellcome Trust Centre for Neuroimaging, University College London, UK; [2]Institute of Cognitive Neuroscience, University College London, UK; e-mail: f.scharnowski@fil.ion.ucl.ac.uk)

Spontaneous fluctuations of ongoing brain activity have a profound impact on perception. For example, human observers are more likely to perceive a visual stimulus if baseline activation in visual cortex at the time of presentation is higher. Here, we used real-time fMRI-based neurofeedback to teach participants to voluntarily regulate the ongoing brain activation of circumscribed areas in their early visual cortex. We then tested how such self-regulated activation influenced subsequent processing of a visual stimulus presented near threshold. We found that the level of activation within early visual cortex directly influenced objective detection thresholds, ie when the participants increased activation they became better at detecting a visual stimulus. A control group who received feedback from a nonvisual brain region did not learn to control visual cortex activation and did not show changes in visual sensitivity. Hence, with real-time fMRI-based neurofeedback it is possible to learn voluntary control over visual cortex activation and thereby to improve visual sensitivity. This new approach allows us to

now use perception as a variable which is dependent on self-regulated brain activation, and therefore to investigate causal links between brain activation and perception.

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m Suppression of a_erent visual information in a patient with dissociative identity disorder and state-dependent blindness

H Strasburger[1,2], B Waldvogel[3], U Mattler[4], D A Poggel[2], J Baudewig[5,6], P Dechent[5], T Wüstenberg[7] ([1]Institute of Medical Psychology, Ludwig-Maximilians-University München, Germany; [2]Dept of Medical Psychology and Medical Sociology, Georg-August University of Göttingen, Germany; [3]Praxis für Psychotherapie, München, Germany; [4]Georg-Elias-Müller Institute for Psychology, Georg-August University of Göttingen, Germany; [5]MR-Research in Neurology and Psychiatry, Georg-August University of Göttingen, Germany; [6]Cluster of Excellence, Languages of Emotion, Freie Universität Berlin, Germany; [7]Dept of Psychiatry and Psychotherapy, Charité Universitätsmedizin Berlin, Germany; e-mail: strasburger@uni-muenchen.de)

The neural basis of conscious vision is still elusive despite numerous experimental and clinical studies. Here, we present the case of patient BT su_ering from dissociative identity disorder after trauma who had been diagnosed as legally blind by neuro-ophthalmic examination including visual evoked potentials (VEPs). After 15 years of blindness, she regained sight and showed normal VEPs in one of her personality states although VEPs are still absent in a remaining blind state. Retinotopic mapping with functional MRI revealed that V1 and thalamic activity were absent during the blind but normal during the sighted state. Findings suggest that BT responded to her trauma with a blind personality state that was attained by complete suppression of visual input at the thalamic level. This case demonstrates a fundamental ability of the brain to block early visual processing in rapid response to personality changes to prevent conscious visual processing at cortical levels.

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m Imagery and perception of objects share cortical representations

R M Cichy[1,2], J Heinzle[2], L Elliott[3], J D Haynes[1,4] ([1]Bernstein Center for Computational Neuroscience, Humboldt University Berlin, Germany; [2]Berlin School of Mind and Brain, Humboldt University Berlin, Germany; [3]Gatsby Computational Neuroscience Unit, University College London, UK; [4]Max-Planck-Institute for Human Cognitive and Brain, Leipzig, Germany; e-mail: rmcichy@gmail.com)

Visual imagery and perception share critical properties. Both can be described by indicating the ‘what‘, ie the content, and the ‘where’, ie the location at which something was seen or imagined. Thus, the question arises to what extent perception and visual imagery share common representations in the human brain. We investigated this question directly using fMRI and multivariate pattern classification. Subjects viewed or imagined objects of four di_erent categories in two di_erent locations. We addressed two questions regarding potential object-related representations shared by imagery and perception: First, do imagery and perception share common representations of category? Second, do imagery and perception share common representations of stimulus location? Our results indicate that imagery and perception share category representations in object-selective cortex. Moreover, most cortical regions selective for a single category during perception maintain their strong selectivity during imagery. We also found a common representation of object location in early and late visual cortex. Interestingly, in late visual cortex location information is distributed unevenly and systematically on the cortical surface: There is more location information on the lateral than on the ventral surface. Our study provides a systematic survey of shared representations of category and location in the ventral visual steam and thus contributes to our understanding of the mechanisms underlying visual imagery.

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m Frontal and mesial temporal brain areas contribute to early visual evoked responses as revealed by electrical source imaging

G Plomp[1], C M Michel[2], M H Herzog[1] ([1]Laboratory of Psychophysics, Brain Mind Institute, École Polytechnique Fédérale de Lausanne (EPFL), Switzerland; [2]Functional Brain Mapping Laboratory, University Hospital of Geneva, Switzerland; e-mail: gijs.plomp@epfl.ch)

Distributed EEG source imaging can reveal the electrical activity underlying visual perception in both cortical and deeper sources. How well electrical source imaging localizes functionally specialized visual areas, such as V1 and MT, has so far not been directly assessed. We used three functional localizer

paradigms that are commonly used in fMRI to assess the localization accuracy for primary visual cortex, motion-sensitive areas, and face-sensitive areas. EEG source localization showed initial activations in striate and extrastriate areas at around 70 ms after stimulus onset that were quickly followed by extensive cortical, as well as subcortical activation. Functional motion and face-selective areas were successfully localized at around 170 and 150 ms respectively, with margins below 2 cm. The results furthermore show for the first time that the visually evoked C1 component has generators in the frontal eye fields and in mesial temporal areas, such as the parahippocampal gyrus.

m A global network of contextual facilitation and suppression in human visual cortex

F Sharifian, L Nurminen, S Vanni (AMI Centre and Brain Research Unit, LTL, Aalto University School of Science and Technology, Finland; e-mail: fariba@neuro.hut.fi)

Context modulates neural responses in mammalian visual cortex, and this e_ect has been connected to statistics of visual input. A recent model (Ventral Stream Interaction, VSIA) form our group (Vanni and Rosenström, unpublished) suggested that contextual modulation is associated with decorrelation which creates more independent neural tuning functions across hierarchical levels. We designed a functional magnetic resonance imaging (fMRI) experiment to study the e_ective parameters and conditions for decorrelation in voxel population and how spatial distribution of response in human visual cortex a_ects suppression and facilitation.We examined eight subjects with ring-shaped center (1–3.2°), near surround (3.2–5.5°), far surround (9.8–12°) or the combination of center and surround. The stimuli comprise sinusoidal grating of 0.5 c/deg at 15% contrast. Results show that already in V1, but especially in extrastriate areas, fMRI signals are modulated far away from the strongest response. In addition, in line with VSIA model, we found a subset of voxels following optimal decorrelation. Our results show that facilitation (suppression) is mostly associated with di_erent (the same) signs of fMRI signal activation when two stimuli active the same voxels. The results support the VSIA model suggesting that the mechanism of decorrelation includes a global network of multiple visual areas.

m Unconscious perceptual processes and their impact

S Hochstein[1,2], A Barlasov-Io_e[1,2], M Jacob[1,2], M Pavlovskaya[1,2], E Shneor[1,2] ([1]Interdisciplinary Center for Neural Computation, Hebrew University, Jerusalem, Israel; [2]Life Sciences Institute, Hebrew University, Jerusalem, Israel; e-mail: shaul@vms.huji.ac.il)

While it is quite evident that we are not aware of all cortical activity, evidence is still sparse concerning what unconscious information is usable for task performance. The famous case of blindsight underscores the importance of this issue in brains with specific damage.We present cases of the use of information of which (healthy) participants are not consciously aware. (1) Following brief presentation of four pacmanlike forms, which describe a rectangle, a triangle (by 3 pacmen), or no form at all (eg with jumbled or outward-facing pacmen), subjects often report that they have not detected the illusory contour form, (when one was present), but they are nevertheless well above chance at guessing its shape. (2) Searching for a pair of identical patterns in an array of otherwise heterogeneous patterns, (with target present in 50% of trials), eye movement patterns concentrate on the target (when present), well before participants are aware of its presence. (3) In a novel search task, performance is dramatically modified by use of eye-of-origin information, of which participants are wholly unaware. (4.) Neglect patients perceive scene statistics taking into account elements in the neglected field, and whose presence they do not report. These examples demonstrate not only that information of which we are unaware is usable for task performance, it also points to the high-level nature of such unconscious information. As in reverse hierarchy theory, these phenomena point to a site-independent neural correlate of conscious perception.

POSTER SESSION: APPLIED VISION

m1

E_ect of visualization of free time and class schedule in a schedule management tool for university students to improve their time management ability

Y Kiritani, M Miyamoto, Y Shimizu, Y Tamagaki (Dept of Design Science, Chiba University, Japan; e-mail: kiritani@faculty.chiba-u.jp)

Information per se is invisible. Information provision appealing to senses is e_ective to convey its abstract meaning to users. We have studied the e_ect of visualization of various information (eg Kiritani et al, 2009 IASDR). The present study proposed a schedule management specialized tool for university students and confirmed the e_ect of visualization of free time and class schedule of university. Previous studies revealed that students were conscious of their poor time management ability, but there was no tool specialized for students. In preliminary experiments, 11 students tested current PC schedule

management tools like iCal for 2 weeks. Results showed users' stress about input but their hope to use the tools. Thus, we decided to propose a web application tool. Our proposal showed the class schedule as a main component, their private schedule in another tab, and free time in a pie chart. Free time meant unplanned time at that point; we intended to make students conscious of free time for time management. Five experiments over two months verified and brushed up the proposal. Visualization of free time and class schedule was e_ective for time management especially for students who had a cavalier attitude towards time.

m2

Evaluating pixel-based visualization

R Borgo[1], K Proctor[2,1], M Chen[1], I M Thornton[2] ([1]Computer Science Dept, Swansea University, UK; [2]Dept of Psychology, Swansea University, UK; e-mail: r.borgo@swansea.ac.uk)

Pixel-based visualization is a popular method of conveying large amounts of numerical data graphically. Application scenarios include business and finance, bioinformatics and remote sensing. We examined how the usability of such visual representations varied across di_erent tasks and block resolutions. Stimuli consisted of temporal pixel-based visualizations simulating monthly temperature variation over a six-year period. In the first study, we included 5 tasks that exerted di_erent perceptual loads. Performance varied considerably as a function of task, ranging from 75% correct in low-load tasks to below 40% in high-load tasks. Uniform patches improved performance by around 6% relative to higher

block resolution. In the second user study, we focused on a high-load task for evaluating month-to-month changes across di_erent regions of the temperature range. We found that errors related directly to the non-linear sensitivity of human vision in low-intensity and high intensity areas of our display range and to the consequences of standard luminance correction. We were able to reduce errors by using multiple colour bands and e_ectively compressing the overall intensity range. In a final study, we examined more fully the influence of block resolution on performance, and found block resolution had a limited impact on the e_ectiveness of pixel-based visualization.

m3

Long-term home-based therapy in people with convergence insu_ciency

P Nawrot[1], A Przekoracka-Krawczyk[1], P Ja´skowski[2] ([1]Laboratory of Vision Science and Optometry, Fac. of Physics, Adam Mickiewicz University, Poznan, Poland; [2]Dept of Cognitive Psychology, University of Finance and Management Warszawa, Poland; e-mail: pawel.nawrot@amu.edu.pl)

The aim of this study was to assess impact of long-term (5 months) home-based vision therapy on the reduction of asthenopia in people with convergence insu_ciency. In the majority of similar studies such a therapy lasted 12 weeks and was claimed to be rather ine_cient (mean 37.5%) compared to o_cebased therapy with home reinforcement (mean 67.45%). Eight women, fulfilling 4 of 5 clinical criteria (asthenopia, exophoria/intermittent exotropia at near and failing Sheard's criterion, low AC/A ratio, high NPC, accommodative dysfunction) were selected and qualified for the vision training. A survey being modelled on CISS-V15 was used in order to determine the rate of ailments before and after trainings. After vision trainings survey score (13.9) was significantly lower (3.0) and all the patients noticed improved comfort. With reduction of asthenopia symptoms, improvements of some vision parameters (facility of accommodation, NPC or positive vergence range at near) were also noted. Our results showed that home-based vision training is an e_ective mean of reducing symptoms in patients with convergence insu_ciency when is used in long term therapy.

m4

If you have to judge the equilibrium state of objects, it's worth learning the physical rule!

F Samuel, D Kerzel (Faculté de Psychologie et de Sciences de l'Éducatiion, Université de Genève, Switzerland; e-mail: Francoise.Samuel@unige.ch)

In earlier research we found that in too many instances participants judged that 2D objects would fall though they were in stable equilibrium. We aimed at finding out whether this 'fall' bias was attributable to a perceptual error or due to a lack of physical knowledge about what determines equilibrium. In the first part of a within-subject three-part experiment, observers indicated whether an object was balanced or would fall. In the second part, participants repeated the balanced–unbalanced judgments, but following explanation of the physical law (ie, that an object is balanced if its center of mass is above the support), and being encouraged to use this knowledge. In the third part, we asked participants to indicate the center of mass of the objects. Results showed that the 'fall' bias decreased significantly from the first to the second part, suggesting that the bias was mainly attributable to lack of knowledge of the physical law. Nonetheless, a residual bias remained, which was intriguing given that the subjective location of the object center would have predicted a bias in the opposite direction.

POSTER SESSION: BIOLOGICAL MOTION

m5

Perceived attractiveness from biological motion: A question of symmetry?

I Arend[1], R Ward[2], C Roether[3], L Omlor[3], M A Giese[2,3] ([1]Dept of Psychology, Ben-Gurion University of the Negev, Israel; [2]Dept of Psychology, Bangor University, UK; [3]Hertie Institute for Clinical Brain Research, University of Tübingen, Germany; e-mail: arend.psy@gmail.com)

Human body shape and motion a_ord many socially relevant cues, such as personality, emotional state, and attractiveness. Evolutionary biologists have proposed that bilateral symmetry provides a sign of biological fitness, since only high quality organisms can maintain the development of symmetrical traits in spite of environmental perturbations and genetic stress. While it has been shown that facial symmetry increases the level of perceived attractiveness, the role of symmetry in the perception of body movement remains largely unexplored. We investigated the influence of spatiotemporal symmetry on the perception of attractiveness and gender from gait. Methods: We motion-captured the gaits of 15 individuals. The three-dimensional joint angle trajectories were decomposed into symmetric and anti-symmetric parts by appropriate spatiotemporal transformations. By weighted mixing of these parts, we generated gaits with di_erent levels of symmetry (highly symmetrical to highly asymmetrical gaits). Twenty-one participants rated these patterns for attractiveness and gender. Results: Gait symmetry increased attractiveness ratings and perceived femininity. However, perfectly symmetrical gaits did not significantly improve attractiveness ratings in comparison to natural gaits. We discuss the implication of these findings for understanding the evolution of body traits.

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m6

Disambiguating biological motion
I M Thornton, M Garvey (Dept of Psychology, Swansea University, UK;
e-mail: i.m.thornton@swansea.ac.uk)
In the absence of explicit cues, many point-light animations are equally consistent with a figure approaching or receding in depth. Parametrically increasing the availability of perspective cues can shift the default interpretation of depth (Schouten and Verfaillie, 2010 Behavior Research Methods 42 161-167). When field-of-view angles are small, figures are seen as facing the viewer (FTV), when field-of-view angles are large, they are seen as facing away (FA). We examined whether additional context cues interact with this field-of-view e_ect. On each trial, a 45° oriented walking figure, with either 0°, 53°, or 112° field-of-view, was flanked on either side by a computer-animated flow-field. The flanking scene simulated camera movement in depth, either forward (expanding flow) or backwards (contracting flow) along a city street. The proportion of FTV responses for each target (0.9, 0.6, 0.1) showed the expected field-of-view e_ect. There was a reliable decrease in FTV responses when flanking motion was consistent with movement into the scene. However, this flanker e_ect varied as a function of target field-of-view (12%, 18%, 1%). Eccentricity of flanker relative to target had no e_ect on the pattern of results. These findings suggest scene context may be integrated before the assignment of figure depth.

m7

Facilitation of biological-motion detection by motor execution does not depend on attributed body side
A Christensen, W Ilg, H-O Karnath, M A Giese (Hertie Institute f. Clinical Brain Research, CIN, University Clinic Tübingen, Germany; e-mail: andrea.christensen@klinikum.uni-tuebingen.de)
Concurrent motor execution influences the perception of biological motion. Exploiting a novel virtualreality paradigm for the study of the influence of motor execution on the recognition of biological motion, we tested how mapping of the body scheme of the observer onto the visual stimulus a_ects the modulation of biological motion perception by motor execution. Methods: Participants were presented in real-time with their own arm movements, shown as point-light figure on a translucent screen. In addition, mirror-reflected versions (along the vertical axis) of the same stimuli were presented. Detection thresholds for the point-light arms in scrambled noise were determined in a 2AFC task, varying the number of noise dots and computing d. values. Results: Facilitation of biological motion detection by concurrent motor execution was found only if the motion direction in the visual stimulus was consistent with the executed arm movement ($p<0.05$). This was independent on the instruction, whether the point-light stimulus represented a person seen from the front or the back. Conclusions: Facilitation of biological motion perception by motor execution is based on an automatic spatial matching process,

which is independent on complex, task-dependent, transformations of the body scheme between executed and observed actions.
[This work was supported by the EC FP6 projects COBOL and TANGO, the DFG, the Fortüne program]

m8

Characteristics of visual sex recognition mechanisms
R van der Zwan, C MacHatch, D Blair, A Brooks (Laboratory of Cognitive Neuroscience and Behaviour, Southern Cross University, Australia; e-mail: rick.vanderzwan@scu.edu.au)
The ability to discriminate between sexes is an essential skill for all social animals. Mistakes can be costly. Humans, like other animals, have evolved cortical mechanisms for mediating sex discriminations that are quick and, usually, unconscious. The aim of these experiments was to explore, using visual stimuli, the characteristics of those mechanisms. Despite a report by others (Barclay et al, 1978 Perception & Psychophysics 23 145-152) that inverting point-light walkers led to reversals in the perceived sex of an actor (for example, upright figures that were female when inverted looked male) we found no evidence for orientation tuning. Naïve observers presented with upright or inverted saggital (Experiment 1) or frontal (Experiment 2) point-light walkers always were accurate and consistent in their sex discriminations. Importantly, discriminations were made with no speed/accuracy trade-o_s. Those data suggest sex-perception mechanisms, unlike other visual perception mechanisms, are orientation invariant. That hypothesis was tested in Experiment 3 using a gender-aftere_ects paradigm (Jordan et al, 2006 Nature Neuroscience 9 738-739). Aftere_ect magnitude was independent of the orientation of adapting and test stimuli (upright/upright; upright/inverted; inverted/upright; inverted/inverted). These data suggest that sex recognition mechanisms have unique characteristics.

m9

Acceleration patterns in the perception of biological motion
B Aragão[1], J A Santos[1], M Castelo-Branco[2] ([1]School of Psychology, University of Minho, Portugal; [2]IBILI, Faculty of Medicine, University of Coimbra, Portugal;
e-mail: brunoaragao@sapo.pt)
A lot of natural stimuli are characterized by acceleration patterns. However, available studies are inconclusive about the importance of these patterns on visual perception. Empirical findings seems to both sustain that acceleration patterns might have, or might have not, a significant role on visual perception [Runeson, 1974 Psychological Research 37 3-23; McIntyre et al, 2001 Nature Neuroscience

4(7) 693-694]. In a recent study Chang and Troje [2009 Journal of Vision 9(1) 19-17] stressed the role of acceleration patterns for the perception of biological motion. Nevertheless, we have a limited understanding about the implications of these patterns for translational stimuli. The present study aimed to investigate how acceleration patterns influence the perception of biological translational motion. We manipulated the velocity of the translational component (maintaining spatial characteristics). This allowed us to create a continuum of stimuli that ranged from natural motion to constant velocity. When two stimuli are presented simultaneously participants are asked to choose which appears more natural. Data shows that subjects choose the stimulus closest to the natural motion—biological motion. Results reveal a great accuracy in detecting the stimulus closest to biological motion, which suggests that acceleration patterns are important in the perception of translational biological motion.
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m

10

On the role of attention and eye movements for the perception of animacy from a single moving object

J Schultz (Dept of Human Cognition, Perception and Action, Max Planck Institute for Biological Cybernetics, Germany; e-mail: johannes.schultz@tuebingen.mpg.de)

We previously developped stimuli allowing parametric control over the percept of animacy evoked by the movements of a single object, without contribution from spatial arrangement, shape or structure of the object (Schultz and Dopjans, 2008 Perception 35 ECVP Supplement, 154). As observers tend to follow the stimulus with their eyes while performing animacy judgments, we quantified these eye movements in the present study (Experiment 1). In Experiment 2, we tested the importance of eye movements and attention for task performance by forcing subjects to fixate while judging animacy. In Experiment 3, attentional resources were further reduced by asking subjects to perform a secondary task at fixation while judging animacy. Experiment 1 showed that the distance between eye fixations and the stimulus increased with changes in animacy, compatible with a greater di_culty in following animate-looking stimuli. Combined results across experiments show that the strength of the changes in percept tends to be reduced with fixed gaze and is significantly decreased in the dual-task setting. In the

latter, the greatest disruption in stimulus processing appears to result from detecting and reporting the fixation targets rather than just splitting attentional resources. These results suggest that at least partially sustained attention is required for animacy judgments about our single moving dot stimulus.
[Supported by the Max Planck Society]

m

11

Combination of image expansion and known size explains time-to-passage of biological motion

S Mouta[1,2], J A Santos[3], J López-Moliner[1,4] ([1]Vision & Control of Action Group, Dep. de Psicologia Bàsica, University of Barcelona, Spain; [2]INESC Porto, Instituto de Engenharia de Sistemas e Computadores, Portugal; [3]Escola de Psicologia, Universidade do Minho, Portugal; [4]Institute for Brain, Cognition & Behaviour (IR3C), University of Barcelona, Spain; e-mail: smouta@psi.uminho.pt)

It is important in everyday tasks to estimate the time it takes an object to reach an observer, time-tocontact (TTC), or when it will pass us, time-to-passage (TTP). However, we do not solely interact with inanimate objects but also with people. It is known that the visual system does not integrate biological motion (BM) linearly over space and time with constant e_ciency (Neri Morrone and Burr, 1998 Nature 395 894-896), but little is known about judging TTC/TTP of BM. In a TTP task we presented expanding point-light walker (PLW) animated with either biological or rigid motion (RM). Subjects had to decide whether the PLW passed them before or after a reference time (1 s) signaled by a tone. Due to its higher complexity, BM conveyed a poor expansion pattern with more noise. Subjects judged that BM passed sooner than RM. Even so BM allows judging TTP well enough in so far as we did not find significant di_erences on precision and reaction time between BM and RM. Moreover, we show that observer knowledge of walker size combined with image expansion influences their interceptive judgments, as it happens for rigid objects [López-Moliner Field and Wann, 2007 Journal of Vision 7(13):11, 1-8].
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POSTER SESSION: CLINICAL VISION AND AGEING

m

12

Neural correlates of impaired object recognition after stroke

M Prass[1], C Grimsen[1], A Kraft[2], A Kastrup[3], M Fahle[1] ([1]Dept of Human Neurobiology, University of Bremen, Germany; [2]Vision & Motor Group, Charité Berlin, Germany; [3]Stroke Unit, Klinikum Bremen-Mitte, Germany; e-mail: mprass@uni-bremen.de)

While severe object agnosia occurs predominantly after bilateral occipito-temporal lesions, performance

in object recognition is impaired in some patients su_ering from unilateral lesions (see Grimsen et al., this conference), while not in others. To study how processing of object identification after stroke is mediated on a neural level, we used functional magnetic resonance imaging to compare the brain activity in ventral occipital areas between healthy participants and stroke patients. Patients had unilateral lesions in occipito-temporal cortex with intact calcarine sulcus and normal visual acuity and visual fields. Using a rapid event-related paradigm (animal/non-animal categorization), where images were presented left or right of a fixation point, we obtained category specific activation in di_erent areas of ventral occipital cortex in normal observers. For animals bilateral activity was found both in the lateral occipital cortex and the fusiform gyrus. Activity for nonanimals was found more medial and anterior of fusiform gyrus. However, in patients the pattern of activity di_ered between the lesioned and intact hemisphere, and from that of healthy participants. The e_ect of unilateral lesions in occipito-temporal cortex on neural responses in a categorization task is discussed under aspects of plasticity and hemispheric di_erentiation.
[Supported by the German Research Foundation (FA119/17-1)]

m

13

Objectively monitored amblyopia treatment in patients aged 4 to 16 years: Insight into plasticity of the visual system

C M Diehl, I Bachert, M Lüchtenberg, A Zubcov, C Ohrlo_, M Fronius (Dept of Ophthalmology, J.W.Goethe-University, Frankfurt, Germany; e-mail: Corinna.Diehl@gmail.com)

Calculating e_ciency of occlusion therapy can be used to assess plasticity in the visual system of amblyopic patients. In a prospective study occlusion of 22 amblyopic patients was electronically recorded over a period of 4 months using occlusion dose monitors (Simonsz et al, 1999 Strabismus 7 113-123; Fronius et al, 2009 Graefe's Archive 247 1401-1408). Gain in visual acuity and e_ciency of therapy were compared for under 7 year (N=10, mean age 5.7±0.8 years) versus over 7 year old children (N=12, mean age 10.9±2.8 years). Multiple regression including all patients was performed to

analyse factors influencing acuity gain. Median gain in crowded visual acuity was 0.3 log units for the younger (mean occlusion 3.6±1.3h/d) and 0.2 log units (mean occlusion 4.4±1.3 h/d) for the older group. E_ciency, ie acuity gain per 1000 hours occlusion, was higher in younger (median 0.76 log units/1000 h) than in older patients (0.37 log units/1000 h), although the di_erence did not reach significance (p=0.059). Multiple regression revealed initial acuity (p=0.004) and age (p=0.03) as independent significant factors influencing acuity gain. For the first time e_ciency of occlusion has been calculated over a wide age range. Age and initial acuity were found to be important independent influencing factors for acuity gain.
[Supported by Bielschowsky-Society; DOG; Augenstern]

m

14

Test repeatability in visual hyperacuity tasks

A-M van der Meer, A C Lobecke, W M Harmening (Dept of Zoology and Animal Physiology, RWTH Aachen University, Germany; e-mail: wolf@bio2.rwth-aachen.de)

Psychophysical thresholds derived from Vernier acuity tasks are usually only a fraction of the eye's resolving power. Vernier acuity was thus termed a hyperacuity phenomenon. It was shown that measures of hyperacuity may be used to address visual function independent of irrelevant optical interferences, eg the presence of cataracts. Along a similar line of argument, Vernier acuity was proposed suitable to research the aetiology of amblyopia. Despite its aptitude to address the neural fraction of the observer's visual capabilities, measures of hyperacuity have not found their way into clinical routine. One reason may be relatively large test variability in the standard, but psychophysically disadvantageous, 2-AFC Vernier task. To arrive at a feasible degree of repeatability, a larger number of trials may be advisable. On the other hand, long testing procedures usually a_ect levels of subject fatigue and motivation, and introduces training e_ects, all which may degrade test accuracy in a non-systematic fashion. With a set of di_erent hyperacuity stimulus configurations and psychophysical procedures, we here explore how test repeatability can be altered without increasing trial numbers. We introduce an automated, 8-AFC, self-paced staircase task with a centroid stimulus that delivers hyperacute thresholds with relatively high precision after 36 trials.

m

15

Visual perception of incomplete images: neuropsychological analysis

R M Vlasova, A A Romanova, T V Akhutina (Psychological Faculty, Lomonosov Moscow State University, Russia; e-mail: rosavlas@gmail.com)

Participants were 47 right-handed children (with mean age 6.5) tested applying the methods of neuropsychological assessment. The data has allowed distinguishing 3 experimental groups with relative weakness of: (1) executive function, or (2) analytic left hemisphere strategy of visual and verbal processing, or (3) holistic right hemisphere strategy of information processing. Participants were asked to recognize and name 12 monochromatic incomplete images. Three experimental groups were

significantly di_erent in their recognition capacity (p=0,01; 1 group>2 group>3 group). The verbalperceptive errors were typical for al three groups; the perceptive errors close to the target were more attributable for group 2; the fragmentation errors (the problem to recognize the whole image by its part) were characteristic for group 3; the perceptive errors far from the target were more typical for groups 1 and 3. Performance in incomplete-images test depends on the participant's individual neuropsychological profile therefore the incomplete-images test is appropriate for diagnosis of neuropsychological individual di_erences in visual perception.

m

16

Near work, outdoor activities and/or level of education—do they a_ect myopia prevalence?

S T Lin[1], H X Yang[1], L K F Tey[1], K M Nah[2] ([1]Defence Medical & Environmental Research Institute, DSO National Laboratories, Singapore; [2]RSAF Aeromedical Centre, Singapore Armed Forces, Singapore; e-mail: lshengto@dso.org.sg)

Singapore has the highest prevalence of myopia in the South-east Asia. The objective of this study is to provide an update on the prevalence of myopia in the Singapore Armed Forces. A cohort study was carried out on 17 393 mainly male volunteers, aged between 16 to 21 years old, who were pre-enlistees to the Singapore Armed Forces. A demographic survey was conducted to determine their level of education, size of house that they stay in, and the amount of visual work done daily for near and distance. The refractive status and corneal curvature was measured using the Huvitz NRK-3100 autorefractor. The data suggested that lower education level and longer hours spent on outdoor activities are associated with less myopia. In contrast, frequent near work is associated with more myopia. While these traits are consistent with the findings 10 years ago, correlations between level of myopia and education, housing, near work and distance work were very weak. The lack of a linear relationship could be due to a natural

upper limit on the level of myopia. Further analyses and investigations are needed to determine the level or ratio of near and distance activities that a_ect myopia.

m

17

Subjective everyday perception, cognition and memory among the Japanese elderly population

O Ishihara[1], Y Itsukushima[2] ([1]Dept of Psychology in Social Welfare, Shizuoka University of Welfare, Japan; [2]Dept of Psychology, Nihon University, Japan; e-mail: osamu@suw.ac.jp)

Generally memory performance declines as one gets older (Craik and Salthouse, 2008 The Handbook of Aging and Cognition, 3rd edition, Psychology Press, New York). 'On the tip of the tongue' is a widely-known expression. Everyday slips or lapses have already been thoroughly investigated. However, few studies have examined how older people feel about their daily perceptive, cognitive, and memory activities. For this reason, we have developed a self-report questionnaire to measure for which everyday perception, cognition, or memory functions the elderly feels inferior to the young. In our recent research, we selected for our questionnaire 36 items about daily perceptive, cognitive, and memory performance. We then conducted at-home interviews of 1722 people aged 65 to 74 years residing in Tokyo. In a factor analysis we extracted 7 items labelled 'facial recognition', 'memory', 'use of advanced informational tool', 'prospective memory', 'perception', 'autobiographical memory', and 'use of memory aid'. In a future study we will examine the relationship between those subjective aspects against real performance in perception, cognition, and memory performance.

m

18

The impact of visual aura on cortical functioning: Filling-in mechanisms and mVEP responses

E G Hall, A Holcombe, E Smith, A Vo (School of Psychology, University of Sydney, Australia; e-mail: ehal6869@uni.sydney.edu.au)

An illusion called 'visual aura' is associated with migraine headaches, but can also occur alone. The phenomenon often includes a scotoma, an area of impaired vision surrounded by normal vision. The nature of the scotoma and the aura's relationship to visual functioning more generally is unknown. The impact of aura on filling-in mechanisms was investigated by aura participants observing a variety of visual stimuli during aura (4 participants over 11 episodes). Observations showed evidence of filling-in of scotomas during visual aura, but not consistently across stimuli or observers. Apparently visual aura varies in its impact and a_ects the visual process of filling-in di_erentially. A second investigation used multifocal visual evoked potentials (mVEP), a technique developed from traditional VEP, to examine cortical responses of those with visual aura. Traditional VEP studies of migraineurs have yielded inconsistent findings. mVEP responses were recorded from those who experience aura with or without migraine headache (N=18), those who experience only migraine headache (N=7), and controls (N=21). Preliminary results found participants with aura show significantly smaller amplitude in the right hemisphere than controls, challenging previous VEP findings that those with migraine show larger responses.

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m

19

Cross-orientation masking in amblyopia

J M Medina, J Carvalho, S Franco (Center for Physics, University of Minho, Portugal;
e-mail: jmanuel@fisica.uminho.pt)

Cross-orientation masking (XOM) describes the psychophysical detection of a Gabor pattern masked by a superimposed stimulus with similar spatial and temporal characteristics but orthogonally oriented. In the present study we have examined the role of XOM in treated amblyopes that have varying degree of anisometropia. Binocular and monocular contrast detection thresholds were measured for horizontal Gabor stimuli under the simultaneous presence of vertical Gabor maskers. Test contrast threshold versus mask contrast (TvC) functions were scaled for achromatic stimuli in both contrast and threshold units. In normal control subjects, binocular summation e_ects were higher at low mask contrasts (a summation ratio within 1.4–2) (Meese et al, 2008 Visual Neuroscience 25 585-601). Anisometropic amblyopes showed null or poor binocular summation over the entire mask contrast range (a summation ratio equal to or less than 1.2). Although the TvC functions were elevated in the amblyopic eye, XOM in amblyopes was similar to the normal control range. The results suggest that the shape of XOM remains invariant in amblyopic vision.

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Poster session: Clinical vision and ageing

Monday

23

m

20

Latencies of visual evoked potentials by stimulating central and peripheral retina

G Krumina, D Grieze (Dept of Optometry and Vision Science, University of Latvia, Latvia;
e-mail: gkrumina@cfi.lu.lv)

The aim of this pilot study was to evaluate the visual evoked potential by stimulating central and peripheral areas of retina. The experiment was done using four monitors. One was placed for stimulation the central part of retina and three for stimulation the periphery. The stimulation of retina was done in three ways: central part, peripheral part, and full field retina (central together with periphery). Peripheral visual stimuli were placed in binocular field area. The stimuli size was 4, 8, and 16 degrees and temporal frequency was 1 Hz (two reversals per second). Visual evoked potentials were recorded monocularly and binocularly. First findings showed the amplitudes of peripheral retinal parts were less then measured from central retina. However latencies values of first negative peak from stimulating peripheral retinal parts were smaller (up to 47–52 ms) as from stimulating central or full field retina (up to 74–79 ms). The same is for first positive peak. The latencies value from stimulating peripheral retinal parts were up to 68–72 ms. The findings of peripheral and central retinal parts could be characterisation of mango- and parvo-pathway information flow speed. The next step will be to find out the latencies values by normal peripheral visual field and by damaged periphery.

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Parvocellular pathway impairment in age-related macular degeneration: Evidence from high- and low-pass filtered scene categorization

B Musel[1], R Hera[2], S Chokron[3], D Alleysson[1], C Chiquet[2], J P Romanet[2], C Peyrin[1]
([1]Laboratoire de Psychologie et Neurocognition, Université Pierre Mendès France, France;
[2]Service d'Ophtalmologie, Hopital Universitaire de Grenoble, France; [3]Service de Neurologie, Fondation Ophtalmologique Rothschild, Paris, France; e-mail: benoit.musel@upmf-grenoble.fr)

Blindness in age-related macular degeneration (AMD) results from the loss of central cones and rods due to damage originating in the retinal pigment epithelium. Due to the retinal anatomy, we expected that AMD a_ects more parvocellular (P) pathway originates from central cones/midget ganglion cells than magnocellular (M) pathway originates from peripheral rods/parasol ganglion cells. We investigate here the residual perception of AMD patient using ecological and complex natural scenes filtered in low and high spatial frequencies (LSF and HSF) to stimulate M and P pathways, respectively. AMD patients and healthy age-matched participants were tested mono-ocularly. Stimuli were black and white photographs of natural scenes, sized 32°×24° of visual angle. AMD patients made significantly more errors and were slower to categorize HSF than LSF scenes while healthy participants categorized HSF scenes as well as LSF scenes (for both accuracy and reaction times). Furthermore, AMD patients categorized LSF scenes as well as healthy participants, while they made significantly more errors and longer correct reaction times to categorize HSF scenes. The present findings highlight a specific deficit in HSF processing during natural scene perception, opening the prospect of a possible deficit of the P pathway in AMD patients.

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Fast oscillations of the human retinal standing potential in myopic subjects

A D Kurtev, E Alchits, M R Gerdvisheh (Physiology, Saba University School of Medicine,

Netherlands Antilles; e-mail: akurtev@saba.edu)
The retinal pigment epithelium (RPE) plays a critical role in ocular growth regulation and refractive development (Rymer and Wildsoet, 2005 Visual Neuroscience 22 251–261). The electrophysiology of RPE can be assessed by oculographic recording of the fast and slow oscillations in the retinal standing potential (RSP). In this study we compare the fast oscillation of the RSP in emmetropes and myopes. The fast oscillations were recorded monocularly using MP 100 system with AcqKnowledge 3.8 software (Biopac Inc.) and SuperLab Pro (Cedrus Corp.). Each subject was presented with four light–dark cycles. We used a flat screen as a stimulus field. The average ratio of the amplitude in the dark to the amplitude in the light was calculated for each subject. The amplitudes of the individual saccades were used to obtain the time course of the changes during the light and dark periods. The results show no significant di_erence in the dark/light ratio and the time course during the dark and light periods between the emmetropes and myopes. Therefore, if there were a di_erence between the two groups in the electrophysiology of the RSP it would likely be present in the slow oscillations of the RSP and the Arden ratio.

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Poster session: Clinical vision and ageing

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Evaluation of Memantine e_ect in Alzheimer's disease by means of electrophysiological methods

Z Kubova[1], J Kremlacek[1], J Szanyi[1], J Langrova[1], M Kuba[1], M Valis[2] ([1]Faculty of Medicine in Hradec Králové, Charles University, Prague, Czech Republic; [2]University Hospital, Charles University, Czech Republic; e-mail: kubova@lfhk.cuni.cz)

We tested visual evoked potentials to pattern-reversal (PREPs) and to motion onset (M-VEPs) and also visual cognitive event related potentials (ERPs) in 17 patients with mild-to-moderate Alzheimer disease (AD) treated with Memantine (non-competitive NMDA antagonist) and in 15 gender and age matched normal subjects to verify whether these methods could help as an objective tool for AD diagnostics and/or for assessment of a therapeutic e_ect. The patients were examined before Memantine administration and after 3 and 6 months after the treatment onset. Besides electrophysiology, also ADAS-cog test was performed. Whilst PREPs were comparable in patients and controls, there were significantly smaller N160 peak amplitudes of M-VEPs and longer P300 latencies of ERPs in patients. Significant M-VEPs reduction confirms a suspected deficit in motion perception in AD. The found ERP di_erences do not enable AD diagnostics because ERPs display a high inter-individual variability and so individual ERP latencies can stay in the range of a broad norm. More promising is their intra-individual longitudinal comparison for a treatment evaluation. However, in our patients Memantine did not show any significant benefit according to both ADAS-cog and the electrophysiological parameters.

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'Plus-minus averaging' increases reliability of VEPs examination

M Kuba, J Kremlacek, Z Kubova, F Vit (Faculty of Medicine in Hradec Králové, Charles University, Prague, Czech Republic; e-mail: kuba@lfhk.cuni.cz)

One of the factors limiting utilization of evoked potentials for an objective evaluation of sensory information processing in the brain is their di_cult recognition/low reliability in some conditions. In visual evoked potentials (VEPs) it holds mainly for subjects with bad concentration to visual stimulation or simultaneous motoric activity (eg children), for subjects with decreased visual perception, for special visual stimuli with parameters close to perceptual thresholds or presentation in periphery of the visual field etc. In such situations the recorded average VEPs can be of very small amplitude with unstable baseline, which either does not allow any evaluation or the obtained data have a low reliability. Although a method 'plus-minus averaging' (Schimmel, 1967 Science 157 92-94) helping to verify authenticity of average response was suggested already a long time ago, it is not so far routinely used for the mentioned purposes. We will present examples of transient and steady-state VEPs enabling convincing conclusions about visual perception in border conditions, when VEPs amplitudes are around 1 _V only. Using of the 'plus-minus averaging' reduces also examination time because the standard averaging of single responses can be stopped automatically when a required level of the remaining noise is achieved.

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Visual backward masking deficits in schizophrenic patients are associated with polymorphisms in the nicotinic receptor _7 subunit gene (CHRNA7)

M Roinishvili[1], G Bakanidze[2], E Chkonia[3], A Brand[4], M H Herzog[5], I Puls[2] ([1]Dept of Behaviour and Cognitive Functions, I. Beritashvili Institute of Physiology, Tbilisi, Georgia; [2]Genetic Section, Dept of Psychiatry and Psychotherapy, CCM, Charité Universitätsmedizin, Berlin, Germany; [3]Dept of Psychiatry, Tbilisi State Medical University, Georgia; [4]Center for Psychiatry and Psychotherapy, Klinikum Bremen-Ost, Germany; [5]Laboratory of Psychophysics, Brain Mind

Institute, École Polytechnique Fédérale de Lausanne (EPFL), Switzerland;
e-mail: maya_ro2002@yahoo.com)
Visual backward masking (BM) deficits are often proposed to be trait markers for schizophrenia revealing the genetic underpinnings of the disease. Here, we show that, indeed, masking deficits in the shinethrough e_ect are associated with polymorphisms in the nicotinic receptor _7 subunit gene (CHRNA7).
In the shine-through e_ect, two vertical bars are slightly o_set in the horizontal direction. Observers indicate this o_set direction. When the Vernier is followed by a grating, Vernier o_set discrimination deteriorates for controls but much more strongly for the patients. Here, we found masking performance of patients strongly correlated with mutations on the rs904952 SNP and a related haplotype. The results further support the significance of CHRNA7 as an important candidate gene for schizophrenia. Furthermore, BM is a reliable endophenotype which may help to identify additional candidate genes and pathophysiological pathways in schizophrenia.
Poster session: Contours and crowding
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Early visual processing deficits in the elderly: anterior increases and posterior decreases of electrical source activity
M Kunchulia[1], G Plomp[2], M Roinishvili[1], M H Herzog[2] ([1]Dept of Behaviour and Cognitive Functions, I. Beritashvili Institute of Physiology, Tbilisi, Georgia; [2]Laboratory of Psychophysics, Brain Mind Institute, École Polytechnique Fédérale de Lausanne, Switzerland;
e-mail: kunchmari@yahoo.com)
We compared temporal processing in elderly and young controls using EEG and electrical neuroimaging. Subjects discriminated the o_set direction of Vernier stimuli in four conditions: Vernier only, mask only, Vernier immediately followed by a mask, and Vernier followed by a mask after a 150 ms SOA. The elderly showed a markedly decreased performance when the Vernier was immediately followed by a mask. Statistical analysis of the electrical sources in this condition showed decreased activity in occipital and fusiform areas at around stimulus onset, and increased activity in right inferior parietal area cortex (BA40) at around 170 ms. Hence, ongoing electrical activity in higher level visual areas is decreased in the elderly, while parietal cortex shows evoked increases that may reflect increased spatial attention. Across the four stimulus conditions elderly showed a distinct EEG scalp topography at around 150 ms that was not observed in young controls. In addition, elderly showed markedly decreased responses at around the N1 latency. Electrical source imaging across the stimulus conditions around this latency revealed decreased electrical activity in the precuneus and cingulate cortex, and increased activity in the inferior parietal, the medial and superior frontal gyrus, as well as in the caudate nucleus. Results are in line with the posterior–anterior shift account of aging and show that a reorganization is apparent around stimulus onset, as well as in visual processing before 200 ms.
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Oculomotor performance in mild cognitive impairment
K K Alichniewicz[1], H Nebl[1], F Brunner[1], H H Klünemann[2], M W Greenlee[1] ([1]Institute for Experimental Psychology, University of Regensburg, Germany; [2]Dept of Psychiatry, Psychosomatics and Psychology, University of Regensburg, Germany;
e-mail: karolina.alichniewicz@gmx.de)
Performance on oculomotor tasks declines with age. Impairments of visuospatial functioning in Alzheimer's disease (AD) exceed the e_ects of normal aging, especially concerning saccadic inhibitory control and error-correction. Mild cognitive impairment (MCI) is thought to be a transitional stage to AD. However, the extent of oculomotor system impairment has rarely been studied in MCI. To characterize possible eye movement deficits the widely used antisaccade task was chosen that helps to distinguish between di_erent types of dementia and other forms of degenerative disorders [Garbutt et al, 2008 Brain 131(5) 1268-1281]. Saccadic performance of 35 patients with amnestic MCI and 25 age-matched healthy controls was investigated using a High Speed Video Eyetracker Toolbox. The experiment consisted of an antisaccade task and a reflexive prosaccade task. Subjects had either to look towards or away from peripheral stimuli presented along the horizontal midline immediately. MCI patients performed significantly less correct antisaccades and showed a higher rate of direction errors (initial prosaccade towards stimulus before antisaccade). There were no di_erences between groups on the prosaccade task. These results indicate that MCI patients have problems with inhibitory mechanisms and eye movement control. Therefore oculomotor assessment may provide a valuable tool in the diagnosis of MCI.
POSTER SESSION: CONTOURS AND CROWDING
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Visual contour integration and segmentation: e_ects of aging
V Robol[1], M Barollo[1], S Cansino[2], C Casco[1] ([1]Dept of General Psychology, University of Padova, Italy; [2]Laboratory of NeuroCognition-Faculty of Psychology, National Autonomous University of Mexico, Mexico; e-mail: valentina.robol@unipd.it)

Perception of circular disconnected contours requires the integration of relevant local orientation information across space and the inhibition of irrelevant orientations. Using a detection of deviation from circularity task, the present study examined whether the e_ciency of either integrative or inhibitory visual mechanisms, or both, declines in elderly age. We compared young and elderly observers' sensitivity in detecting the deviation from circularity of a contour formed by Gabors in three conditions: when all elements were tangential to the contour, with and without the presence of randomly oriented backgroundnoise, and when they had alternated tangential and orthogonal orientations, without background-noise. In agreement with previous studies, we found that young observers were not impaired in the mixed condition with respect to the tangential condition, suggesting the involvement of a high-level mechanism

responding to the global closure information provided by tangential local orientations even if they are interspersed with orthogonal ones. Instead, elderly observers were specifically impaired in the mixed condition, suggesting a reduced capability of inhibiting non-tangential information along the contour, and were also less e_cient in inhibiting irrelevant orientations in the background. These results support the suggestion that integrative mechanisms are not a_ected whereas inhibitory mechanisms are not e_cient in elderly age.

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A horizontal bias in contour integration: Evidence from psychophysics and electrophysiology

M Schipper[1,2], U Ernst[1,3], H I Stecher[1,2], K Pawelzik[1,3], M Fahle[1,2] ([1]Bernstein Group for Computational Neuroscience, University of Bremen, Germany; [2]Dept for Human Neurobiology, University of Bremen, Germany; [3]Dept for Neurophysics, Institute for Theoretical Physics, University of Bremen, Germany; e-mail: marc.schipper@uni-bremen.de)

Perception of shapes in natural scenes is strongly modulated by global context interacting with local integration processes, to construct a representation from local image features. An example is contour integration, grouping nearly collinear, aligned edge elements into coherent forms.We investigate how global and local integration processes interact, and whether they are separate or combined processes. We combined EEG recordings with psychophysical experiments. Observers had to detect contours of locally aligned edge elements, embedded in a background of randomly oriented distractors. The global form of the contours was either a horizontal or a vertical ellipse. For horizontal ellipses, both reaction times and detection thresholds are smaller than for vertical ellipses (horizontal bias). Ellipses aligned radially to the fixation spot are easier detected than tangentially aligned ellipses. The relative strengths of these e_ects depend on the eccentricity of the contours. The horizontal bias is confirmed by electrophysiological data, showing a significant di_erence in the occipital and parietal ERPs between horizontal versus vertical ellipses starting 150 ms after stimulus onset. ERP di_erences in frontal electrodes appear later starting 220 ms after stimulus onset. Hence the horizontal bias emerges already during contour integration, suggesting that local and global form integration interact very early.

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A new approach to investigating the contrast sensitivity to contour integration in the fovea

A S Baldwin, T S Meese (School of Life & Health Sciences, Aston University, UK; e-mail: baldwias@aston.ac.uk)

Previous studies have varied the length, width and aspect ratios of Gabor-like stimuli to investigate the underlying mechanisms for contour integration. However, assessment is compromised at detection threshold by retinal inhomogeneity, which causes a loss of benefit from the outer parts of the contours as they are elongated beyond the central fovea. We tackled this problem here by constructing various types of elongated stimuli from arrays of abutting micropatterns, giving us experimental control over each element in the contour. Each square micropattern was made from a single cycle of a sine-wave, modulated by an orthogonal half-cycle of cosine-wave. We constructed 'snakes' from micropatterns with the same orientation as the contour, and 'ladders' by arranging them at right angles. We varied the overall lengths of the contours (the number of micropatterns) and measured contrast detection thresholds for (i) the outer pair of micropatterns, (ii) the inner micropatterns, and (iii) entire contours, where contrasts were adjusted to normalize sensitivity to the inner and outer parts. Preliminary results suggest that contrast integration extends over at least 8 stimulus cycles for 'snakes'. Further experiments will investigate the e_ects of varying the phase and orientation of the micropatterns and the curvature of their alignment.

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Invariance perception of illusory and fragmented figures: Dependence on age

V N Chikhman[1], V M Bondarko[2], L A Semenov[2], Y E Shelepin[2], S D Solnushkin[1] ([1]Information Technology, Pavlov Institute of Physiology, Russia; [2]Vision Physiology, Pavlov Institute of

Physiology, Russia; e-mail: niv@pavlov.infran.ru)
The perception of fragmented and illusory contours of di_erent sizes was investigated in schoolchildren of 7–17 years old and adults. We used line drawings of common objects and discs with deleted sectors, which represented illusory Kanizsa contours when discs were in particular positions, separations and orientations. We found that the Kanizsa illusion appeared at practically the same separations between discs for the smallest disks' diameters for all observers. At Kanizsa illusion appearance, the ratio of the separation between discs and disc diameter was smaller when we used larger disc diameters. This ratio

increased with increasing age of observers. Obtained results provide evidence for the absence of size invariance when perceiving the Kanizsa illusion in our experimental conditions. In experiments with fragmented images we found an improvement in image recognition with observers' age, increasing up to 13–14 years, coinciding with the findings of other investigations (Kovács, 2000 Vision Research). The probability of recognition of fragmented line drawings increased significantly with decreasing stimulus size for children of 7–12 years, indicating that size invariance at recognition for fragmented line drawings was absent in these children. However, size invariance was found for observers of 13–17 years and for adults in this task.
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Relation between perceptual position of contour and polarity of border-ownership
M Kikuchi[1,2], M Anshita[1], M Yoshimine[2] ([1]School of Computer Science, Tokyo University of Technology, Japan; [2]Graduate School of Bionics, Computer and Media Sciences, Tokyo University of Technology, Japan; e-mail: kikuchi@cs.teu.ac.jp)
When we see two concentric circles, the perceptual sizes of the outer/inner circle tends to be smaller/larger than a single circle (Delboeuf illusion). In the meantime, the perceptual trajectories of the convex/concave contours are biased toward the inner/outer side, respectively (Fantoni et al, 2005 Vision Research 45 1047-1062). This study investigated psychophysically whether those phenomena about contour perception can be generalized as the positional biases toward belonging region, ie borderownership
side. A disk and a circular hole by RDS are simultaneously presented on a computer display. The figural regions (disk and the occluding plane of the hole) have the same disparity, and the background regions also have the identical disparity. Subject's task was to answer which radius, disk or hole, is larger. According to the responses, perceptual size of the hole (or disk) is adjusted to the constant disk (or hole), using staircase method. We obtained a result that perceptually hole is always larger than disk ($p<0.01$). Additional experiments were performed to investigate the di_erence of perceptual positions of 2D/3D straight edges with opposite ownership polarities, and we found the di_erence between them ($p<0.05$). These results suggest that the positional bias of contour perception exists in our visual system according to the polarity of border-ownership.

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E_ect of contrast on the size perception of Gabor patterns
T Yoshizawa[1], S Tagami[1], T Kawahara[1], Y Tanaka[2,1] ([1]Human Information System Laboratory, Kanazawa Institute of Technology, Japan; [2]Vision Division, Miki Optical Institute, Japan; e-mail: tyoshi@his.kanazawa-it.ac.jp)
Gabor patterns have been popularly used in the visual psychophysics, the primate physiology and the brain imaging, because these patterns can be manipulated in spatial frequency and spatial domains independently. However, it has been known that Gabor patterns have some inconvenient characteristics that changing contrast of the pattern makes change in the perception of a size of the pattern. We investigated this phenomenon more detail property. We measured contrast thresholds of discrimination of perceived sizes between a test and a reference Gabor pattern (_=0.625 deg, 8 cpd-carrier). We varied contrast of the reference pattern from 10.0 to 80.0% at four orientations (0, 45, 90, 135 degrees) of the carrier component of the Gabor. We tested increment and decrement thresholds at which observers could discriminate di_erence of the perceived size by chance. All the thresholds increased as contrast of the reference pattern increased, the function of the increment threshold was shallower than that of the decrement threshold. The result indicates that size perception di_ers between near threshold contrast and high contrast, suggesting asymmetrical interaction between size and contrast perception.
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Cue combination in contour integration tasks
M Persike, G Meinhardt (Dept of Psychology, Methods Section, University of Mainz, Germany; e-mail: persike@uni-mainz.de)
The interaction of orientation alignment, spatial frequency and color cues in contour integration

was studied with Gabor random fields. Target contours were defined by collinear orientation, spatial frequency contrast or color contrast between contour elements and the surround, and both pairwise combinations of orientation alignment with the feature contrast cues. Subjects had to detect the contour and further identify its shape. Cue summation, defined as the performance benefit due to the combination of orientation alignment with a feature contrast cue, was evaluated and tested against predictions derived from probability summation and linear summation. Cue summation with spatial frequency was

substantial and increased alongside the performance level achieved with single cues until it was limited by ceiling e_ects. The summation gain was particularly large when spatial frequency of contour elements deviated from the surround towards lower carrier frequencies. Color contrast as a second cue contributed only moderately to the visibility of the contour and summation gains did not exceed the prediction from independent feature processing. Results indicate di_erent integration sites of orientation alignment with spatial frequency as opposed to color. Further, a special role of spatial frequency contrasts directed towards lower carrier frequencies is discussed and corroborated by supplementary experiments.

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How good Gestalt counteracts clutter in contextual modulation

B Sayim, M Manassi, M H Herzog (Laboratory of Psychophysics, Brain Mind Institute, École Polytechnique Fédérale de Lausanne (EPFL), Switzerland; e-mail: bilge.sayim@epfl.ch)

Performance deteriorates when a target is flanked by distractors. For example, Vernier thresholds increase when the Vernier is flanked by lines. Recently, we showed that deterioration was reduced when the lines were made part of a 'good Gestalt', eg a rectangle. We proposed that flanker interference diminishes when target and flankers do no fall in the same perceptual group. Here, we presented Verniers flanked on each side by eight vertical irregularly arranged lines. The lines appeared strongly cluttered. Thresholds were more than 10 times the unflanked thresholds. When the cluttered lines were surrounded by rectangles, their deleterious e_ect almost ceased completely. We suggest that the rectangles reduced interference because they ungrouped the Vernier from the clutter. Our results support the proposition that perceptual grouping is one of the key factors in contextual modulation.

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'Crowding' not always spoils identification: Surrounding stimuli can improve discriminability of the central ones

G I Rozhkova, A E Belozerov, D S Lebedev (Institute for Information Transmission Problems, Russian Academy of Sciences, Moscow, Russia; e-mail: gir@iitp.ru)

Surrounding stimuli (flankers or distractors) are usually believed to impair the discriminability of a central test stimulus, and such impairment has been demonstrated in many studies. The described crowding and crowding-like e_ects are considered as the negative consequences of feature pooling, lateral masking, lateral inhibition, etc. However, other studies indicate facilitation of detection and orientation discrimination in cases of threshold stimuli composed of Gabor or Gaussian patches (Levi et al, 2002 Journal of Vision 2 140-166). In our opinion, there are some reasons to expect a positive influence of the specific surrounding stimuli for a wide variety of the test stimuli. Firstly, it is known that small threshold images are poor stimuli for accommodation. Therefore, specific surrounding stimuli could help in achieving more accurate and stable focusing. Secondly, the structure of some optotypes allows recognition on the basis of asymmetry that could be detected more easily in the presence of certain additional stimuli forming a reference frame around the test. This expectation was confirmed both by calculations and by visual acuity measurements that revealed a reliable and reproducible increase in visual acuity (about 0.1 logMAR) due to specific surrounding stimuli for tumbling-E symbols in half of the subjects tested.

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In contextual modulation, bigger is not better for low luminance stimuli

M Manassi, B Sayim, M H Herzog (Laboratory of Psychophysics, Brain Mind Institute, École Polytechnique Fédérale de Lausanne (EPFL), Switzerland; e-mail: mauro.manassi@epfl.ch)

Performance on a target can be modified by contextual elements. For example, thresholds strongly increase when a Vernier is flanked by two lines. Increasing the number of flankers reduces contextual interference when the flankers are shorter or longer than the Vernier: bigger is better. However, there is no improvement when flankers have the same length as the Vernier [Malania et al, 2007 Journal of Vision 7(2):1, 1–7]. Stimuli were 80 cd/m2 on a black background. Here, we used stimuli with the luminance of 1 cd/m2. Performance deteriorated similarly as in the 80 cd/m2 condition when the Vernier was flanked by two lines that were longer than the Vernier. However, increasing the number of flankers did not improve performance as in the 80 cd/m2 condition: bigger is not better. Our results show that contextual modulation is highly dependent on the luminance of the stimuli.

Poster session: Contours and crowding
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Cue size and array density a_ect crowded target visibility
E M Rislove[1], D M Levi[1,2] ([1]Graduate Program in Vision Science, University of California Berkeley, USA; [2]School of Optometry, University of California Berkeley, USA; e-mail: erislove@berkeley.edu)
Recent studies have implicated limitations of the spatial resolution, profile and localization of attention as key factors in visual crowding. Our aim in this experiment was to examine the e_ects of cue-size and array density on an observer's ability to identify a crowded target in the normal periphery. Observers were signaled as to target location by a red Gaussian blob presented briefly at one of twenty possible locations in the periphery, followed by an array of black and white vertical and horizontal bars on a gray background of mean luminance. Observers were then asked to identify the contrast polarity and orientation of the bar that was presented at the cued location. We varied both the cue size and density of the target array in blocks of 120 trials; several runs were collected for each cue-size density pairing. Unsurprisingly, we found that decreasing the distance between display elements hindered performance; however, we were surprised to find that using what would otherwise be an inappropriately large cue improved performance for loosely packed arrays. This suggests that a wider focus of attention may be more useful than a narrow one when texture elements are easily individuated.
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Crowding a_ects eye-movements patterns in word reading
E Bricolo[1], C Salvi[1], M Martelli[2], L S Arduino[3,4], R Daini[1] ([1]Dept of Psychology, University of Milan Bicocca, Italy; [2]Dept of Psychology, University of Rome, Italy; [3]Faculty of Educational Sciences, University LUMSA, Rome, Italy; [4]Institute of Cognitive Sciences and Technologies, CNR, Rome, Italy; e-mail: emanuela.bricolo@unimib.it)
Crowding is a phenomenon that characterizes the normal periphery limiting letter identification when other letters surround the signal. Crowding can be eliminated by increasing the distance between the letter centres beyond a critical spacing, that is by letter spacing or by letter size increase. In reading, crowding defines an uncrowded span, the number of character positions available for correct identification, and predicts rate [Pelli and Tillmann, 2008 Nature Neuroscience 11(10) 1129-1135]. We investigated the nature of the reading limitation of crowding by analyzing eye-movement patterns. Stimuli consisted of two items, varying across trials for lexicality (words or pseudowords), word length (4, 6, 8 letters) and letter spacing (Experiment 1). Subjects were required to read silently or aloud in di_erent blocks both items in free vision. The number of fixations were higher for spaced than unspaced items and increased with word length. More importantly, spacing the letters reduced the fixations durations. No qualitative di_erences have been found between the two reading conditions indicating that articulatory programming did not influence outcome. Increasing size (Experiment 2) produced the same fixation duration advantage, indicating that only center-to-center letter spacing matters as predicted by crowding. Overall our results indicate that crowding influences normal word reading.
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On the role of source confusion in crowding
A Martinez Antón[1,2], R van den Berg[3], A Schepers[1], A Johnson[1], F W Cornelissen[2] ([1]Dept of Experimental Psychology, University of Groningen, The Netherlands; [2]Laboratory for Experimental Ophthalmology, University of Groningen, The Netherlands; [3]Theoretical Systems Neuroscience Laboratory, Baylor College of Medicine, Houston, USA; e-mail: a.martinez@live.nl)
A visual stimulus presented in the peripheral visual field is harder to identify when surrounded by other objects than when presented in isolation. This phenomenon is called crowding. One particular theory proposes that crowding is largely a consequence of intrinsic uncertainty in the perceived positions of the stimuli which makes observers occasionally confuse the relative locations of stimuli when spacing is small. This is known as 'source confusion' (Strasburger, 2005 Journal of Vision 5 1024-1037). Quantitative evidence for this theory is, however, limited. Here, we ask to what extent source confusion can explain critical spacing, the spatial extent over which flanking stimuli cause crowding of a target. In our experiment, we presented two Gabor stimuli, one to the left and one to the right of fixation. Eccentricity and contrast of the stimuli were varied. After each trial, participants indicated which of the two stimuli was perceived as being located closer to fixation. The results show that the intrinsic spatial uncertainty in perceived object location is positively related to eccentricity and negatively related to contrast, but is small in comparison with the critical spacing associated with crowding. Hence, we conclude that source confusion can give at most a partial explanation of crowding.
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Poster session: Emotions and cognition

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Pattern recognition and individual foveola architecture mapped by optical coherence tomography
O A Vakhrameeva[1], T V Selchenkova[1], M Sukhinin[2], Y E Shelepin[1] ([1]Laboratory of Vision Physiology, Pavlov Institute of Physiology, Russian Academy of Science, Russia; [2]Medical Military Academy, Dept of Ophtalmology, Russian Ministry of Defense, Russia; e-mail: olga.vakhrameeva@gmail.com)
The aim of our work was to study the relationships between the size of incomplete figure at recognition threshold and the individual size of fovea. Twelve volunteers with normal visual acuity took part in the study. The axial length and refraction of their eyes were obtained. The central retina structures were examined with optical coherent tomography (OCT). In psychophysical investigations we measured the recognition thresholds for fragmented line drawings of everyday objects using Gollin's test.We analysed the relations between that thresholds and the size of figures. The size we used were 0.19, 0.32, 0.71, 1.44, 13.0, and 50.0 deg. Analysis shows that for stimuli size from 1.4 to 50 deg the recognition thresholds remains constant and wile stimuli size decreases from 0.71 to 0.19 deg thresholds gradually increase. We compared psychophysical data with linear size of retina's structures. The pictures with size 0.19, 0.32, and 0.71 deg fitted the diameter of foveola for each subject. It does not depend on the individual linear size of the retinal structures. If the stimulus size is less than diameter of fovea the recognition is not su_cient. This limitation can be explained by sampling multiplicative noise of periferal part of visual system.
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POSTER SESSION: EMOTIONS AND COGNITION

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Task demands and capacity limits in the processing of emotional facial expressions
S Baggott[1], R Palermo[2], M A Williams[1] ([1]Macquarie Centre for Cognitive Science, Macquarie University, Australia; [2]Dept of Psychology, Australian National University, Australia; e-mail: sbaggott@maccs.mq.edu.au)
Processing relevant information at the expense of irrelevant information is critical for completing many common tasks. However, disregarding irrelevant information that is evolutionarily salient may have potentially catastrophic consequences. It should therefore be very di_cult to ignore faces, even when irrelevant, given their biological and social importance. Research has shown that irrelevant faces are processed when names are task-relevant. If it is another face that is task-relevant, though, it appears that irrelevant faces are not processed, prompting the proposal that face processing is subject to capacity limits with only one face processed at a time. We investigated whether emotional facial expression processing would also be subject to capacity limits by using facial expressions as both targets and distractors. We manipulated task demands to examine the e_ect of directing attention towards responding to the sex (male/female) or emotion (happy/angry) of target faces. Emotional information from irrelevant faces was processed regardless of whether the task directed attention to sex or emotion information, whereas sex information from irrelevant faces was only processed when sex classification was required. This demonstrates the high priority assigned to processing emotional information from facial expressions and indicates that face processing is not always capacity limited.

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How mood influences global versus local processing of visual information: an eye tracking study
R Bianchi, E Laurent (Laboratory of Psychology, University of Franche-Comté, France; e-mail: dysangile@gmail.com)
Happy and sad moods are respectively associated with a global and a local processing of visual information in similarity judgment tasks. However, ocular behaviour in such tasks is still poorly documented. In the present study, participants were eye-tracked as they performed a similarity judgment task under mood induction. Participants had to indicate whether a target figure was more similar to a first comparison figure matching its global features or to a second comparison figure matching its local components. It turned out that participants in happy mood were more likely to match figures on a global basis than participants in sad mood. Moreover, participants in happy mood exhibited a lower proportion of both within-figure fixation number and within-figure fixation duration than participants in sad mood. This study confirms previous findings linking happy mood to a global and sad mood to a local processing of visual information. Taken together, these results highlight the role of mood in the weighing of global and local dimensions of visual search.

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Virtual storytelling of fairy tales: Towards simulation of emotional perception of text

E P Volkova, I V Alexandrova, H H Bülthoff, B J Mohler (Dept of Human Perception, Cognition and Action, Max Planck Institute for Biological Cybernetics, Tübingen, Germany; e-mail: Ekaterina.Volkova@Tuebingen.MPG.de)
Emotion analysis (EA) is a rapidly developing area in computational linguistics. For most EA systems, the number of emotion classes is very limited and the text units the classes are assigned to are discrete and predefined. The question we address is whether the set of emotion categories can be enriched and whether the units to which the categories are assigned can be more flexibly defined. Six untrained participants annotated a corpus of eight texts having no predetermined annotation units and using fifteen emotional categories. The inter-annotator agreement rates were considerably high for this difficult task: 0.55 (moderate) on average, reaching 0.82 (almost perfect) with some annotator pairs. The final application of the intended EA system is predominantly in the emotion enhancement of human–computer interaction in virtual reality. The system is meant to be a bridge between unprocessed input text and auditory and visual information: generated speech, animation of facial expressions and body language. The first steps towards integrating text-based information annotated for emotion categories and simulation of human emotional perception of texts in story telling scenarios for virtual reality are already made. We have created a virtual character, whose animation of face and body is driven by annotations in text.

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Orthogonal autonomic responses to emotional pictures

M Ohmi (Laboratory for Affective Design Engineering, Kanazawa Institute of Technology, Japan; e-mail: ohmi@his.kanazawa-it.ac.jp)
Emotional pictures evoke autonomic responses. The sympathetic nervous system is activated by emotion of fear or surprise which is elicited by emotional pictures. Although it has been reported that there are linear relationships between heart rate and the valence (pleasant–unpleasant), and between skin conductance and the arousal (excited–calm), the orthogonality between these two autonomic responses is not well documented. We measured heart rate and skin conductance of ten undergraduate participants when 37 IAPS (International Affective Picture System) pictures with uniformly distributed valence ratings (4.60–8.10) and arousal ratings (4.80–6.99) were presented. The results showed that the peak heart rate acceleration increased linearly with increase of the valence and there was no effect of arousal on heart rate. On the other hand, the skin conductance increased linearly with increase of the arousal for lower range, but it decreased linearly for higher arousal range. There was also no effect of valence on this nonlinear relationship between the arousal and the skin conductance. The results suggest that the autonomic responses are evoked orthogonally by the dimension of valence and the dimension of arousal. (Lang et al, 1993 Psychophysiology 30 261-273)

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Watch your body language! Relative affective blindsight for fearful bodily expressions

B M C Stienen[1], B de Gelder[1,2] ([1]Cognitive and Affective Neuroscience Laboratory, Tilburg University, The Netherlands; [2]Martinos Center for Biomedical Imaging, Massachusetts General Hospital and Harvard Medical School, USA; e-mail: bstienen@gmail.com)
Nonconscious affective perception has repeatedly been shown for facial expressions but not for bodily expressions while being highly salient and known to influence our behavior towards others. Lau and Passingham [2006 Proceedings of the National Academy of Sciences of the United States of America 103(49) 18763-18768] found a case of relative blindsight using a parametric masking design. We used a comparable approach to measure the unconscious perception of bodily expressions. Subjects had to detect in separate experiments fearful, angry and happy bodily expressions among neutral bodily actions as distractors and subsequently the subjects had to indicate their confidence. The onset between target and mask varied from −50 to +133 ms. D-prime as well as the confidence ratings showed that the bodies could be detected in all SOA conditions. Importantly, a phenomenon which we coined 'relative affective blindsight' was found, defined as two SOA conditions showing same d-prime values, while the confidence ratings differed. In fact, this was only found for fearful bodily expressions, not for angry and happy bodily expressions.
[Supported by European Commission (COBOL FP6-NEST-043403) grant]

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Dose cognitive behavioral intervention affect emotional saccadic localization performance?

T Imaruoka[1], K Matsumoto[2], M Ohmi[1] ([1]Dept of Information Science and Human Communication, Kanazawa Institute of Technology, Japan; [2]Division of Humanities and Social Sciences, Kanazawa Institute of Technology, Japan; e-mail: imaru@neptune.kanazawa-it.ac.jp)
As a previous study showed [Bannerman et al, 2009 Cognition & Emotion 23(5) 930-954], emotional stimuli are processed and localized quickly in the emotional saccadic localization (ES) task. It is well known that such attentional bias to the emotional stimuli is closely related to the anxiety level of the participants. We investigated whether cognitive behavioral intervention to a participant with subclinical

social anxiety would have e_ect on attentional bias to the emotional stimuli. Six volunteers were assessed social anxiety level and participated in the ES task with two varieties of stimulus duration (20 ms, 500 ms). Five of the participants with normal social anxiety showed a consistent pattern of the results (attentional bias to emotional face and longer saccadic latency in the 20 ms condition). However one participant with higher social anxiety did not show attentional bias to the emotional stimuli and showed equivalent saccadic latency in the 20 ms and 500 ms condition. A six-session cognitive behavioral intervention for social anxiety was administered to two participants (one was normal control, another was socially anxious). The intervention moderated the social anxiety level of the anxious participant and changed the ES results of the anxious participant into the similar pattern to the results of the normal control.

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Hemispheric lateralization in processing emotional and non-emotional Kanji words

S Nagae (Dept of Psychology, Fukuoka University of Education, Japan;
e-mail: nagaex@fukuoka-edu.ac.jp)

The purpose of this study was to investigate the contribution of both hemispheres to the perception of positive, negative, and non-emotional Kanji words in normal individuals. Right-handed participants were asked to read aloud the word presented in the visual half-field. Seventy-two words were presented in either the left or the right visual field in random order. Half of these trials were left-side, the other half, right. Each word was presented once to each visual field. Kanji stimuli were presented for a duration of 70 ms. Results indicated that responses to positive and non-emotional words were more accurate in the right visual field (RVF) than those in the left visual field (LVF), but no di_erence was found for negative emotional words. Reaction time results showed that processing of negative emotional words was faster in the RVF than in the LVF although there were no visual field di_erences for positive and non-emotional words. These findings were interpreted as suggesting that the right hemisphere has a processing system for emotionally negative Kanji words.

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Processing emotional facial expressions influences brain activation on a Go/No go task in preschool children

Y Saito (Dept of Psychology, Tokai-Gakuin University, Japan; e-mail: ysaito@tokaigakuin-u.ac.jp)

This study investigated whether processing emotional facial expressions influences frontal brain activation in preschool children. Eleven preschool children were included in this study, and their cerebral blood flows were measured by near-infrared spectroscopy (NIRS). They were exposed to visual stimuli in the form of facial expressions by strangers; happy, sad, and neutral faces. They were divided two groups; one group children push the mouse, if the faces were happy, other group children don't push the mouse, if the faces were happy. A 2 (task: Go and No go) × 2 (stimulus: happy and sad) × 2 (recording site: right frontal area and left frontal area) analysis of variance (ANOVA) for these relative oxy-Hb values was conducted. The ANOVA showed a significant tendency stimulus main e_ect ($F_{1,9}$=3.949, $p<0.10$). The sad stimuli (M=0.291) were more activated than happy stimuli (M=−0.123) in the frontal area. These findings suggest that preschool children's brain were activated sad stimuli in any task, so negative stimuli become the clue of higher cognitive judgment in young children.

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The emotional intention of arbitrary drawings

R Hiraga[1], N Matsuda[2] ([1]Dept of Industrial Technology, Tsukuba University of Technology, Japan; [2]Grad. School of Systems and Info. Eng., University of Tsukuba, Japan;
e-mail: rhiraga@a.tsukuba-tech.ac.jp)

We are seeking a method to identify an emotion of a drawing to increase emotional understanding in nonverbal music communication by presenting the drawing simultaneously. We analyzed 34 closed drawings created to represent one of the four emotions (joy, fear, anger, and sadness) by calculating the principal components and clustering them into 4 groups. We repeated the clustering 100 000 times,

collected centroids, and came to a first step conclusion with two principal components of ruggedness (the first component, ratio=51%, mainly discriminating between joy and fear) and symmetry (the second component, ratio=20%, mainly discriminating between anger and sadness). We added 20 drawings that were the contours of objects in a picture or of illustrations one by one to the set of sample drawings and classify them by k-nearest neighbor method using centroids. The result showed the numbers of drawings classified to joy, fear, anger, and sadness were 5, 4, 5, and 6, respectively. Though about the half of the drawings were classified to emotional groups that were against to human intuition, this way of finding an emotion of an arbitrary drawing decreases the arbitrariness in determining an emotion of the drawings that were classified to emotional groups conforming to human intuition.

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Dehydration changes a_ective responses to visual stimulation
E Laurent, R Bianchi (Laboratory of Psychology, University of Franche-Comté, France;
e-mail: eric.laurent@univ-fcomte.fr)
Recently, the e_ects of dehydration on visual perception were investigated (Changizi and Hall, 2001 Perception 30 1489-1497), showing that dehydration conducts to change the sensitivity to transparency, an essential visual dimension of water. We studied the a_ective responses of participants that we hypothesized to be associated to dehydration and to the attunement of visual experience to sources of hydration. Participants in the 'dehydrated' condition were invited to eat 30 g crisps (0.5 g NaCl), whereas participants in the 'hydrated' condition were invited to freely drink water so as to satisfy any thirst. Then, an advertising video for a worldwide known trademark of soda showing alternatively scenes of sunny and warm places, water availability, and finally soda consumption, was shown to small groups (ie, 6–10 participants simultaneously). When dehydrated, participants reported more pleasure at watching the video and higher levels of clip attractiveness than did hydrated participants. These results concerning a_ective responses to visual stimulation were associated to a specific pattern in which participants declared higher buying probability and consented price for the product. In conclusion, dehydration is associated to global appetitive behaviours that rely on the change of both visual experience (as reported by Changizi and Hall) and a_ective responses to visual stimulation.
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Pupil dilation reflects judgment of uncertainty
K Preuscho_[1,2], B M 't Hart[3], W Einhäuser[3] ([1]Laboratory for Social and Neural Systems Research, University of Zurich, Switzerland; [2]Institute for Empirical Research in Economics, University of Zurich, Switzerland; [3]AG Neurophysik, Philipps-Universität Marburg, Germany;
e-mail: preuscho_@iew.uzh.ch)
Pupil dilation has been implicated as marker for decision-processes since the 1960s. Little is known, however, as to which decision variables this peripheral physiological measure may reflect. One plausible hypothesis states that pupil dilation is related to uncertainty, in particular to errors in judging uncertainty. Here, we employ a simple gambling task to manipulate the perceived uncertainty of a monetary outcome. We study how changes in pupil diameter throughout the task relate to various decision-making variables. We find that changes in pupil diameter reflect errors in judging uncertainty but neither the probability of the outcome nor the expected reward. As pupil diameter under constant illumination is likely to be mediated by norepinephrine (NE) released by the locus ceruleus (LC), we conclude that LC may be a key structure in uncertainty processing. Our data support a recent computational model, which links NE to the perception of decision-making variables, in particular to unexpected uncertainty.
[Supported by DFG-Grant Ei 852/1]

POSTER SESSION: EYE MOVEMENTS I

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An attempt to generate vertical saccades with pairs of contralateral stimuli
S Casteau, F Vitu (Laboratoire de Psychologie Cognitive, CNRS, Université de Provence, France;
e-mail: soazig.casteau@univ-provence.fr)
The metrics of horizontal and oblique saccades are known to reflect the neuronal activity profile in the motor map of the contralateral superior colliculus. The pattern is more complex and less understood for the case of vertical saccades. These involve activity at mirror locations in the two collicular maps, and presumably result from cooperate activity of both colliculi (Robinson, 1972 Vision Research 12 1795-1808) relayed by inter-collicular excitatory connections (Olivier et al, 1998 Visual Neuroscience 15 903-922). Here, we investigated in Humans, whether purely vertical saccades could be generated by visual stimulation of two mirror locations around the vertical meridian. Since lateral-excitatory

connectivity underlies the tendency to move the eyes in between two ipsilateral stimuli (Findlay, 1982 Vision Research 22 1033-1045), a similar global e_ect was expected with contralateral stimulation. The saccade-target stimulus was presented at variable eccentricities (0.5–4°) in the upper right or left hemifield and variable angles from the horizontal meridian (±0–80°), with or without a distractor at the contralateral, mirror, location. Results revealed only a few pure vertical responses to double stimulation, but clear distractor-based eye deviations towards the vertical meridian for large target angles (>60°). Thus, the global e_ect generalizes to contralateral stimulation, but intercollicular facilitation may not su_ce to account for vertical saccades.
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Visual scanpaths as a generalised deficit in schizophrenia
S A Beedie[1], E Shephard[1], I Giegling[2], D P Rujescu[2], D M St Clair[3], P J Benson[1] ([1]School of Psychology, King's College, University of Aberdeen, UK; [2]Dept of Psychiatry, Ludwig

Maximilian University Munich, Germany; 3Dept of Mental Health, University of Aberdeen, UK;
e-mail: psy421@abdn.ac.uk)
Visual scanpaths are the patterns of ocular fixations and saccades produced during scene inspection. Schizophrenia is associated with a 'restricted' scanpath, characterised by longer fixations, reduced fixation frequency and limited spatial exploration. Research using face stimuli has demonstrated a role of a_ect and face processing style in atypical scanning, although replication using geometric shapes and other stimuli suggests that a more basic visuo-cognitive or oculomotor deficit may also be present. To examine whether scanpath disturbances are limited to particular images, eye movements were recorded while schizophrenia patients and nonclinical age-matched controls free-viewed colour scenes varying in semantic content (landscapes, animals, faces, man-made environments, everyday objects, fractals). Regression analyses showed that both observer groups were equally influenced by stimulus content. However, and in parallel with this, between-group variance models showed that 'restricted' scanning was present in the schizophrenia group regardless of image type. The magnitude of the trait deficit was virtually constant across all image types for each scanpath measure. These novel and compelling results underline the presence of a generalised deficit in exploratory eye movements in schizophrenia.
[Supported by Chief Scientist O_ce, FP6-SGENE, Millar MacKenzie Trust, University of Aberdeen]

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Eye-gaze distribution of TV viewers: analysis of fixation data collected by a newly developed eye-gaze tracking system for multiple subjects
K Komine, Y Sawahata, T Morita, S Umeda (Science & Technology Research Laboratories, Japan Broadcasting Corporation (NHK), Japan; e-mail: komine.k-cy@nhk.or.jp)
We have been trying to develop a metric to measure the e_cacy of cinematographic techniques in TV programs based on viewers' eye movements. Probabilistic distributions extracted from fixations of a large number of viewers and the related statistics seem to be promising metrics, as was shown in our previous work [Sawahata et al, 2008 Pattern Recognition 41(5) 1610-1626]. In order to collect a large amount of fixation data to e_ectively apply statistical analysis, we developed a remote eye-gaze tracking system that can measure data from five subjects simultaneously. Using our system, we successfully collected fixation data for 40 minutes of video clips from 80 subjects within only 16 hours in total time. Compared to conventional eye-gaze tracking systems, the system allowed larger head movements, which maintained the measurement accuracy of the subjects' viewing angle within 1–2 degrees at the same level. Furthermore, we extracted the probabilistic distribution of the fixations, represented by Gaussian mixture model, from the collected data and visualized the estimated attended areas in the video clips. Based on our results, we can expect the developed system to be useful in validating visual saliency models by comparing the computed feature maps with the fixation distributions.

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Saccadic hypometria is associated with visual attention deficits in Parkinson's disease
S van Stockum[1,2], M R MacAskill[1,2], T J Anderson[1,2] ([1]Dept of Medicine, University of Otago, Christchurch, New Zealand; [2]Van der Veer Institute for Parkinson's & Brain Research, Christchurch, New Zealand; e-mail: vanev008@student.otago.ac.nz)
Visual attention deficits are associated with saccadic hypometria in Parkinson's disease. In Parkinson's disease (PD) the reflexive saccadic system is generally thought to be intact while the voluntary system is impaired due to dopamine depletion of fronto-striatal circuitry. Saccades (overt shifts of visual attention) and covert shifts of visual attention use partly overlapping neural circuitry. It is not clear if saccadic deficits in PD, which include hypometria and abnormal latencies of saccades, are associated with visual attention deficits. To investigate this issue we used a paradigm adapted from Deubel (2008) to measure oblique reflexive and voluntary saccades with and without a perceptual discrimination task in 20 PD

patients and 20 controls. Compared to controls the PD group made hypometric saccades at normal latencies in the reflexive task and at prolonged latencies in the voluntary task. The additional requirement to make a presaccadic discrimination facilitated the initiation of saccades in both groups. In the PD group this e_ect normalised the performance of voluntary saccades, but it abnormally reduced the latencies of reflexive saccades. The PD group's discrimination performance was impaired in the reflexive task. Interestingly, worse perceptual discrimination performance in the PD group was associated with hypometria of saccades, suggesting that saccadic hypometria and visual attention deficits may have a common origin in PD.

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Walking, talking and looking: e_ects of divided attention on gaze behaviour and visual search performance in a real-world environment
J Wincenciak, A Willis, C Egan (School of Health and Social Sciences, Edinburgh Napier University, UK; e-mail: J.Wincenciak@napier.ac.uk)
Visually-guided behaviour in the laboratory may not always reflect that in larger-scale environments,

using more realistic tasks. (eg Smith et al, 2008 Cogn Process 9 121-126). Here, we explored (1) what people look at; (2) how quickly they find a target; and (3) whether divided attention (counting backwards in 7 s from 100) influences performance in a large-scale, active, visual search task in a real-world environment. Fourteen young adults (19–25 years) were asked to locate a target (white postcard) in a shop window as they walked along a pavement in Edinburgh, UK, under both 'control' and 'divided attention' conditions. Eye movements were recorded using a head-mounted eye tracker and coded manually according to object-based ('what') and location-based ('where') categories. Measurements were made from the point of first fixation on the correct shop display. Participants fixated significantly less often on task-relevant objects, and took significantly longer to find the target in the 'divided attention' condition compared with the control. No di_erences were found in terms of location-based ('where') categories. This suggests that real-world visual search performance in large-scale environments requires the activity of limited capacity, central attentional resources, but that visual scanning strategies ('where' we look) may not.

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Analyzing bottom-up saliency in natural movies

E Vig[1], M Dorr[2,1], E Barth[1] ([1]Institute for Neuro- and Bioinformatics, University of Lübeck, Germany; [2]Schepens Eye Research Institute, Dept of Ophthalmology, Harvard Medical School, USA; e-mail: vig@inb.uni-luebeck.de)

We investigate the contribution of local spatiotemporal variations of image intensity to saliency. To measure di_erent types of variations, we use invariants of the structure tensor. Considering a video to be represented in spatial axes (x,y), and temporal axis t, the n-dimensional structure tensor (nD-ST) can be evaluated for di_erent combinations of axes (2D- and 3D-ST) and also for the (degenerate) case of only one axis (1D-ST). Eye movements recorded on 18 natural videos are used to label locations as fixated or non-fixated. For each location, we compute the invariants (products of eigenvalues) of the nD-ST and use these to predict eye movements on unseen videos with an SVM classifier. We show that the 3D-ST is optimal (average ROC score of 0.656), which means that the most predictive regions of a movie are those where intensity varies along all spatial and temporal directions. Analyzing 2D variations, the 2D-ST evaluated on the axes (y,t) gave the best score (0.638), followed by (x,y) (0.626), and (x,t) (0.625). The 1D-ST yielded 0.606 along the temporal, 0.604 for horizontal, and 0.602 for vertical axis. We conclude that bottom-up saliency is determined by spatiotemporal variations of image intensity rather than spatial or temporal variations.

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Does adding a visual task component a_ect fixation accuracy?

H-J Bieg[1], L L Chuang[1], H H Bültho_[1,2] ([1]Dept of Human Perception, Cognition and Action, Max Planck Institute for Biological Cybernetics, Tübingen, Germany; [2]Dept of Brain and Cognitive Engineering, Korea University, South Korea; e-mail: bieg@tuebingen.mpg.de)

Video-based eye-trackers are typically calibrated by instructing participants to fixate a series of dots, the physical locations of which are known to the system. Unfortunately, this procedure does not verify if fixation has actually occurred at the desired locations. This limitation can be remedied by requiring participants to perform a simple visual discrimination task at each location, thus mandating accurate fixation. Still, it remains an open question whether this modification could a_ect fixation accuracy. In the current study, we compared the accuracy of fixations that were performed with a visual discrimination task and those without such a requirement. Participants either identified the orientation of a small

Landolt C (size=0.1°) or fixated a similar probe without performing the task. Results indicate that participants fixated equally well in both tasks (mean di_. of abs. error=0.01°, Bayes factor B_{01}=4.0 with JZS prior, see Rouder et al (2009 Psychonomic Bulletin & Review 16(2) 225-237]. Given this, we propose the implementation of this visual discrimination task to eye-tracking calibration protocols as it elicits verifiable fixations without compromising fixation accuracy.

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Fixation disparity during reading is a_ected by periodic letter strokes within a word

S Jainta[1], W Jaschinski[1], A J Wilkins[2] ([1]IfADo, Leibniz Research Centre for Working Environment, Germany; [2]Visual Perception Unit, University of Essex, UK; e-mail: jainta@ifado.de)

We investigated the way in which binocular coordination in reading is a_ected by the spatial structure of the text. Vergence eye movements were measured (EyeLink II) in 32 observers while they read 120 single German sentences (Potsdam Sentence Corpus) silently for comprehension. The similarity in shape between the neighbouring strokes of component letters, as measured by the first peak in the horizontal autocorrelation of the images of the words, was found to be associated with (i) a smaller minimum fixation disparity (ie vergence error) during fixation; (ii) a longer time to reach this minimum disparity;

and (iii) a longer overall fixation duration. These results were specific for binocular viewing conditions, ie binocular reading: no e_ects of autocorrelation could be observed for monocular reading. The results help to explain the longer reading times reported for words and fonts with high autocorrelation and may also begin to provide a causal link between poor binocular control and reading di_culties.
[Supported by DFG-project Ja 747/4-1,2]

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Factors explaining fixation disparity, measured with dichoptically presented nonius lines

A Švede[1], J Hoormann[2], S Jainta[2], W Jaschinski[2] ([1]Dept of Optometry and Vision Science, University of Latvia, Latvia; [2]IfADo Leibniz Research Centre, Technical University Dortmund, Germany; e-mail: aigasv@lanet.lv)

Fixation disparity refers to the steady-state error in vergence angle between the visual axes. The neural network model of Patel et al (2001) explains fixation disparity as a result of the asymmetry between convergent and divergent dynamic responses to disparity step stimuli. This concept extends previous feedback control theory based models that refer to one direction of dynamic vergence responses. Further research showed that fixation disparity reflects a bias towards resting vergence. We combined these approaches in order to predict the inter-individual variability in fixation disparity measured subjectively with dichoptic nonius lines for a stationary fusion stimulus. Multiple regression analyses showed the following percentages of variance explained by three independent variables in a sample of 20 subjects. 54% was due to the objectively measured asymmetry in vergence dynamics (calculated from convergent and divergent velocities) and objectively measured heterophoria (as a result of tonic, accommodative, and proximal vergence components). Additional 22% of variance was due to the nonius bias, ie the physical nonius o_set required for perceived alignment of binocularly (non-dichoptically) presented nonius lines. Together, these components were able to explain 76% of the inter-individual di_erences in subjectively measured fixation disparity, showing the influence of oculomotor and perceptual factors.

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Influence of task requirements on manual and oculomotor parameters

A Chavaillaz, J Krummenacher (Dept of Psychology, University of Fribourg, Switzerland; e-mail: alain.chavaillaz@unifr.ch)

While it is well established that manual reaction times to 2D defined feature targets in visual search are expedited relative to 1D defined targets (Krummenacher et al, 2001 Perception & Psychophysics 63 901-917), rather little is known about oculomotor parameters in visual search for such targets. We recorded manual reaction times and eye movements in feature and identification search experiments. Both experiments included 1D and 2D targets. The 1D targets di_ered from the distractors (green vertical bars) by a single unique feature on either the color (red or blue) or the orientation dimension (45° leftor right-tilted) and the 2D targets by a combination of both features. In Experiment 1 (detection task), participants were instructed to trigger a manual response only when a target was present and to refrain from an answer when all objects were identical. In Experiment 2 (identification task—composed of two parts including each either 1D or 2D targets) participants were instructed to respond only to two particular target types. Results showed that manual responses to 2D targets were slower but these targets were fixated faster in the identification than the detection task, suggesting that identical objects generate di_erent oculomotor patterns according to task requirements.
[Supported by the Swiss National Foundation (PDFM1—114415/1)]

Poster session: Eye movements I

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Perseverative eye movements in obsessive-compulsive disorder and schizophrenia

E Shephard[1], S A Beedie[1], J Kuriakose[2], P J Benson[1], D M St Clair[3] ([1]School of Psychology, King's College, University of Aberdeen, UK; [2]Royal Cornhill Hospital, NHS Grampian, UK; [3]Dept of Mental Health, University of Aberdeen, UK; e-mail: elizabeth.shephard.05@aberdeen.ac.uk)

Schizophrenia (SCZ) and obsessive-compulsive disorder (OCD) share many clinical features, eg perseverative obsessional or delusional thoughts associated with frontal lobe impairment. Additionally, these disorders may overlap in deficient eye movement behaviour. Comparable deficits in oculomotor planning and control have been revealed in SCZ and OCD, eg poor voluntary inhibition of reflexive saccadic eye movements, which may reflect a common perseverative visuo-cognitive processing style in these illnesses. However, no thorough assessment of OCD and SCZ performance across a range of oculomotor and cognitive tasks has previously been undertaken. We present data from OCD, SCZ and healthy control individuals tested on a battery of oculomotor tasks (visual scanning, tracking, fixation, saccades) and neuropsychological instruments. Spatial and spectral analyses demonstrated clear di_erences in performance between observer groups. These findings are discussed in terms of perseverative visual attention and cognition processing biases in OCD versus SCZ.
[Supported by Carnegie Trust, Chief Scientist O_ce, University of Aberdeen]

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Eye movements in reading sentence comprehension: a study of a single case with a working memory deficit
D R Mussi, E Bricolo, R Daini, C Papagno (Dept of Psychology, University of Milano-Bicocca, Italy; e-mail: davide.paggio@alice.it)
In order to study the role of working memory in sentence comprehension during reading, the exploratory eye movements of a brain-damaged patient (MC) with a selective impairment of the phonological loop were recorded during a plausibility judgment task and compared to those of seven neurologically unimpaired subjects. Participants were required to judge the plausibility of 160 written sentences of two types: in one di_culty was due to the order of words, in the other to syntactic complexity. During the task, an infrared camera recorded subjects' eye movements. For each sentence, the number of fixations and regressions (going backwards over previously viewed material) were computed. We hypothesized that MC should have made significantly more regressions compared to matched controls, only for sentences requiring the intervention of the phonological loop (ie syntactically-complex ones, such as relative). The results showed that the phonological loop is necessary for oniline processing of sentences that require retention of words in a precise order, but not for syntactically complex sentences. The outcome is discussed with regards to the three major theories on the role of working memory in oniline sentence comprehension (Vallar and Baddeley, 1984; Rochon et al, 1994, 2000; Papagno et al, 2007).
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Recognition and change detection tasks di_erentially influence the time courses of visual fixations and saccades
J Schulz[1], S Pannasch[1,2], B M Velichkovsky[1] ([1]Institute of Psychology III, Dresden University of Technology, Germany; [2]Brain Research Unit, Low Temperature Laboratory, Aalto University School of Science and Technology, Finland; e-mail: jschulz@psychologie.tu-dresden.de)
Influence of task instruction on fixation distributions and scanpaths has been variously demonstrated (eg Yarbus, 1967 Eye movements and vision Plenum Press, New York). Less is known about task influence on the time course of eye movements.We compared fixation durations and saccadic amplitudes over time during tasks of recognition and detection of changes in location of objects. In both tasks, the presentation was interrupted after 1.5 or 5 s for 300, 1000, or 3000 ms. We found that fixation durations increased and saccadic amplitudes decreased within the first 1.5 s but not after 5 s. Subsequent to the interruption we observed short but increasing fixation durations and substantial changes in saccadic amplitudes. Overall, fixation durations were shorter in the change detection task. Saccadic amplitudes did not di_er before but after the interruption: larger amplitudes were found in change detection task. As processing of position information is expected to be dominant in the detection of location changes, these results can be understood as further support of the relationship between gaze behaviour and the two major subdivisions of visual system, the dorsal and ventral streams (Velichkovsky et al, 2002 Transportation Research Part F: Tra_c Psychology and Behaviour 5 145-156).

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Individual di_erences in saccadic and smooth pursuit eye movements
G Bargary, J M Bosten, P T Goodbourn, A J Lawrance-Owen, R E Hogg, J D Mollon (Dept of Experimental Psychology, University of Cambridge, UK; e-mail: gb364@cam.ac.uk)
This study examined the range and reliability of individual di_erences in several oculomotor measures. One thousand participants were tested using standard smooth pursuit and pro- and antisaccade paradigms [Smyrnis, 2008 Brain and Cognition 68(3) 341-358]. In the smooth pursuit task, the variables of interest were the root mean square error of eye position, gain (ratio of eye velocity to target velocity), and number and type of intruding saccades. In the saccadic tasks, the variables of interest were accuracy, latency distribution and velocity characteristics. We report the range and distribution of these variables, as well as correlations between them. We also report a number of internal consistency reliability measures for these variables, as well as test–retest reliabilities based on a randomly-selected 10% of the sample.
POSTER SESSION: LEARNING AND MEMORY
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Retrieval-related activity in early visual areas
M H Sneve[1], D Alnæs[1], T Endestad[1], M W Greenlee[2], S Magnussen[1] ([1]Dept of Psychology, University of Oslo, Norway; [2]Institute for Experimental Psychology, University of Regensburg, Germany; e-mail: m.h.sneve@psykologi.uio.no)
Recent studies of working memory for low-level visual features suggest that early visual areas are involved in the retention of elemental stimulus attributes such as orientation and color [Harrison and Tong, 2009 Nature 458 632-635; Serences et al, 2009 Psychological Science 20(2) 207-214]. We have investigated memory-related activity in early visual areas, using fMRI and a novel version of the delayed

discrimination task. Toward the end of the delay interval, shortly before the test stimulus is presented, a tone signals the upcoming discrimination task, ie a comparison between the test stimulus and the memory trace of the sample stimulus. In a small portion of the trials the test stimulus does not appear; this partial trial approach allows us to investigate the BOLD memory retrieval response uncontaminated by the response due to sensory processing of the test stimulus. Controlling for attentional factors, results indicate increased activity in early visual areas following the tone. We interpret this as retrieval-related signal modulation—early visual areas are involved in a strengthening of the memory representation when it becomes behaviorally relevant.

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What's 'up'? Orientation discrimination while holding orientations in memory

L Scocchia[1], G M Cicchini[2,3], J Triesch[1] ([1]Frankfurt Institute for Advanced Studies, Johann Wolfgang Goethe University, Germany; [2]Dept of Psychology, University of Florence, Italy; [3]Institute of Neuroscience, National Research Council, Italy; e-mail: scocchia@fias.uni-frankfurt.de)

Recent evidence has shown that maintaining a complex object in visual working memory (VWM) slows processing of similar visual stimuli during the maintenance period [Robinson et al, 2008 Journal of Vision 8(16) 1-13]. Here we explored the interaction between the processing of low-level features of simple visual objects and the contents of VWM. Participants were required to memorize the orientation of a Gabor patch and to perform an orientation discrimination task during the retention interval. The discrimination task consisted of judging whether a Gabor patch was oriented 'upward' or 'downward' relative to 45° from vertical. Participants' accuracy and reaction times in the orientation discrimination task were strongly a_ected by the orientation of the memorized stimulus, irrespectively of whether its spatial frequency matched the spatial frequency of the discrimination stimulus. In particular, VWM loads closer to the vertical selectively disrupted performance when the discrimination stimulus was relatively more vertically oriented (ie 41°), whereas VWM loads closer to the horizontal selectively disrupted performance when the discrimination stimulus was relatively more horizontally oriented (ie 49°). A control condition where participants attended to but did not memorize a Gabor patch showed the same pattern of results but a much reduced e_ect.

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Adaptation reveals dissociable costs and benefits of perceptual learning

D P McGovern, N W Roach, B S Webb (Visual Neuroscience Group, School of Psychology, University of Nottingham, UK; e-mail: david.mcgovern@nottingham.ac.uk)

In order to make perceptual decisions, the brain decodes sensory information from populations of neurons. When making fine discriminations, for example, observers rely on neurons tuned away from the discrimination boundary. Adapting these neurons produces a large cost for discriminative accuracy.

Previously we demonstrated that repeatedly practicing fine direction discrimination whilst in an adapted state can overcome this cost. This improved performance is, however, accompanied by a significant increase in threshold when adapting with other, previously ine_ectual adaptors. Here we extend this work by systematically measuring the relative time course of these opposing changes in performance. Before training we measured observers' ability to discriminate small deviations from an upwards direction of motion. Adapting to upwards (0°) motion and directions o_set symmetrically by ±20° induced a small reduction and large increase in discrimination thresholds, respectively. We then varied the number of sessions in which observers repeatedly practiced this task whilst adapted to directions ±20° from upwards. Whereas the cost of adaptation at ±20° disappeared after relatively few practice sessions, threshold elevations induced by a 0° adapter only became apparent with further training. Our results demonstrate that these opposing outcomes of learning can be dissociated, and point to multiple time-dependent learning mechanisms.

[This work was supported by the Wellcome Trust]

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Visual interference by a second learning experience is strongest during asymptotic learning

M Been[1,2], B Jans[1,2], E Lowet[1], D Arnoldussen[1,2], P De Weerd[1,3] ([1]Dept of Cognitive Neuroscience, Maastricht University, The Netherlands; [2]Maastricht Brain Imaging Center (M-BIC), Maastricht University, The Netherlands; [3]Donders Institute for Brain, Cognition and Behaviour, Radboud University, The Netherlands; e-mail: marin.been@maastrichtuniversity.nl)

Reversed hierarchy theory (RHT) [Ahissar and Hochstein, 2004 Trends in Cognitive Sciences 8(10) 457-464] predicts that visual skill learning will induce neural plasticity most strongly in lower-order visual areas while learning reaches its asymptotic phase. We tested that prediction by means of an interference paradigm. Five subjects were trained daily in orientation discrimination at an oblique reference orientation, at two locations in the visual field. After a short break, subjects were trained at

two additional reference orientations, rotated 30° clockwise and anticlockwise from oblique in one of the two locations. The oriented stimuli used during the second learning experience were chosen to be similar to the oriented stimuli used in original learning, so that interference could be expected with latent consolidation induced by original learning in orientation selective neurons in low-level visual areas. Learning measured over 15 sessions was normal in the non-interfered quadrant. In the interfered quadrant, a few sessions of fast learning were followed with asymptotic learning converging on final thresholds two-fold higher than those in the non-interfered quadrant. In line with RHT, this indicates that plastic changes in lower visual areas, where learning is orientation and location specific, take place during asymptotic learning.
[Supported by VICI Grant 453-04-002 from NWO, NLs, to PDW]

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The co-development of perceptual learning and contextual learning in a visual search task

C C Le Dantec, A R Seitz (Sensory Learning Laboratory, University of California Riverside, USA; e-mail: ledantec@ucr.edu)

Contextual learning (CL) and perceptual learning (PL) are two types of learning that have garnered much attention in the vision sciences. CL is the learning of regularities in the environment that allow for better identification of the target-location in a visual search task. PL refers to the visual system learning to better represent (ie become more sensitive to) the elements (target and background) of the visual search. While these two types of learning often co-occur in natural settings (for example, a bird watcher must both know where to look for a bird and how to identify it), they are typically isolated using distinct experimental paradigms. In the present study, we compare the operational measures of both PL and CL as they co-develop within a single visual search task. We find evidence of both CL and PL, PL is specific to the orientations of the search targets and distractors, whereas CL transfers to di_erent orientations. EEG recordings show CL is associated with a larger N2pc, whereas PL is associated with a smaller N1. These results suggest that CL and PL are distinct visual learning phenomena that have di_erent behavioral characteristics and may be processed by di_erent neural systems.

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Perceptual learning for second-order cues in a shape-from-shading task

D N Dovencioglu, A J Schofield, A E Welchman (School of Psychology, University of Birmingham, UK; e-mail: dicl.dicl@gmail.com)

When a corrugated, patterned surface is illuminated this results in first-order modulations of luminance (LM) and correlated second-order modulations of the local luminance amplitude of the pattern (AM). Observers see LM and AM gratings presented in-phase (LM+AM) as shaded corrugations. When an additional anti-phase (LM-AM) component orthogonal to the first component is added to form a plaid,

the LM-AM component is seen as a flat reflectance change (Schofield et al, 2006 Vision Research 46 3462-3482). However, for brief presentations (250 ms) naive observers are unable to di_erentiate the cues. We trained 6 observers over a period of 5 days to discriminate the components of orthogonal LM+AM/LM-AM plaids on the basis of which appeared more corrugated. After training, the AM threshold for discriminating the cues reduced dramatically. This benefit transferred to orthogonal plaids with a di_erent overall orientation but not to the same cues with higher spatial frequency. We then varied the angle between the two members of the plaid. Training transferred when this angle was close to 90° but not for more acute combinations. We conclude that the role of AM in di_erentiating shading from reflectance changes can be learnt at a perceptual level resulting in cue specific performance benefits.

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Bartlett's theory of visual reproduction revisited: Ambiguous face-like stimuli do not necessarily transform to prototypical face schemata

S Albrecht, C-C Carbon (Dept of Psychology, University of Bamberg, Germany; e-mail: sabine.albrecht@uni-bamberg.de)

In 1932 Frederic Bartlett laid the foundation for the later Schema Theory. His findings considerably contributed to the understanding of how previous knowledge a_ects processing of visual stimuli. Empirical proof however is sparse and Bartlett's results are hardly verifiable. We replicated Bartlett's methods of 'serial' (Experiment 1, N=177) and 'repeated reproduction' (Experiment 2, N=53). In both experiments undergraduates inspected particular one of di_erent sketches variing in the degree of faceness. After a delay of a minimum of 15 minutes participants were asked to reproduce their visual imageries. In Experiment 1 we rotated the produced sketches among participants and repeated the procedure five times. In Experiment 2 we asked them to reproduce their visual imageries after minimum weekly delays for five times. In two subsequent studies the participant's sketches were evaluated in the degree of faceness on a 7-point Likert-scale. In contrast to Bartlett's findings the sketches did not become more face-like the more often the reproduction process was performed, indicating more complex cognitive processes underlying the schema formation. For Experiment 1 we even obtained reversed

e_ects with less face-likeness after a series of reproduction. Further research should vary influential factors such as creativity, drawing abilities and delays to get further insights into the formation of memory from visual inputs.

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74

E_ects of face and voice learning on access to semantic information from names

C Barsics (Center for Cognitive and Behavioural Neuroscience, University of Liège, Belgium; e-mail: c.barsics@ulg.ac.be)

Several studies showed that it is more di_cult to retrieve semantic information from recognized voices than from recognized faces. However, earlier studies that investigated the recall of biographical information following person recognition used stimuli that were preexperimentally familiar to the participants, such as famous people's voices and faces. The present study was designed in order to allow a stricter control of frequency exposure with both types of stimuli (voices and faces) and to ensure the absence of identity cues in the spoken extracts. In the present study, subjects had to associate lexical (ie name) and semantic information (ie, occupation) with faces or voices. Interestingly, when asked later to recall semantic information being cued by the person's names, participants provided significantly more occupations for the targets that had been previously associated with faces than with voices. Moreover, participants' performance was not significantly di_erent when names and occupation were associated with voices compared with dog's faces, whose complexity is similar to that of human faces, but for which we have poorer discrimination abilities. These results and their implications for person recognition models, as well as the potential role of the relative distinctiveness of faces and voices, are discussed.

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The role of eye movements during long-term pictorial recall

C S Martarelli, F W Mast (Dept of Psychology, University of Bern, Switzerland; e-mail: corinna.martarelli@psy.unibe.ch)

Previous research suggests that eye movements during perceptual encoding are involved when people later recall from memory images seen before. In this study we focused on eye movements during longterm pictorial recall. Fifteen adults performed a perceptual encoding task, ie they had to visually explore 16 stimuli that were positioned in di_erent areas of a computer screen. Each stimulus presentation was followed by a pictorial recall of the stimulus. The participants had to remember and visualize the stimuli and answer to specific questions about visual details of the stimuli. One week later we repeated the pictorial recall task. During the tasks we measured eye movements (iView X RED Remote Eye-tracking

Device, SMI). We based the analyses on fixations and compared the time spent in the areas in which the pictures were displayed with the time spent in the unoccupied areas. Interestingly, not only in the immediate recall task after encoding but also one week later participants spent more time in the areas where the stimuli were encoded. Thus, we conclude that the location of previously seen objects is stored in long-term memory.

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High-speed memory scanning in a visual change detection task

L Simione[1,2], A Ra_one[1,3], M Olivetti Belardinelli[1,3], C van Leeuwen[2] ([1]Dept of Psychology, Sapienza University of Rome, Italy; [2]Laboratory for Perceptual Dynamics, BSI RIKEN, Japan; [3]ECoNA, Interuniversity Center for Cognitive Processing, Italy; e-mail: luca.simione@gmail.com)

Visual working memory (VWM) is a memory system that allows us to maintain a certain amount of visual information for a few seconds. VWM has a limited capacity [Phillips, 1974 Perception & Psychophysics 16(2) 283-290], estimated in about four objects in mean (Luck and Vogel, 1997 Nature 390 279-281). To be used stored VWM information has to be retrieved. Previous data showed that retrieval of working memory information consists of an exhaustive serial mechanism that scans the storage contents to find the searched item [Sternberg, 1966 Science 153(736) 652-654]. The aim of our experiment was to test the linear augmentation of RT proportionally to memory set size found by Sternberg recording RT in a VWM change detection task, applying the RT registration to Luck and Vogel change detection paradigm. We used only under span set sizes, with one to four colored squares, avoiding influences due to excessive VWM load. Our results show a linear RT increment of about 50 ms for objects, both in positive (di_erent) and negative (same) trials. Interestingly, there is a facilitation of about 100 ms for set size one in the same trials, registered in both the peripheral and center probe experiments.

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Perceptual learning through errorless training

L Bamert[1,2], E M Tartaglia[1], F W Mast[3], M H Herzog[1] ([1]Laboratory of Psychophysics, Brain Mind Institute, École Polytechnique Fédérale de Lausanne (EPFL), Switzerland; [2]Institut de

Psychologie, Université de Lausanne, Switzerland; [3]Dept of Psychology, University of Bern, Switzerland; e-mail: laura.bamert@unil.ch)
Perceptual learning is usually assumed to be stimulus driven. For example, in supervised neural networks, synaptic changes, realizing the learning, are adjusted depending on the error stimuli produced. Suprathreshold stimuli, which do not yield errors, do not yield improvements. Here, in 52 blocks we presented bisection stimuli with an o_set of 50.. (arcsec) yielding more than 97% of correct responses per block. Hence, we expected no learning to occur. Surprisingly, training with the supra-threshold bisection stimuli improved performance for sub-threshold stimuli, as determined by baseline measurements before and after supra-threshold training.

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The rapid emergence of stimulus-specific perceptual learning

Z Hussain[1], P V McGraw[1], A B Sekuler[2,3], P J Bennett[2,3] ([1]Psychology, University of Nottingham, UK; [2]Psychology, Neuroscience & Behaviour, McMaster University, Canada; [3]Centre for Vision Research, York University, Canada; e-mail: zahra.hussain@nottingham.ac.uk)
Is stimulus-specificity the outcome of extended practice or can it occur with a relatively small amount of practice? Separate groups of observers practiced a 10AFC face identification task over two consecutive days, with di_erent amounts of practice on day 1: either 40 or 5 trials per condition. On day 2, half the observers from each group transferred to novel faces. Stimuli were presented using method of constant stimuli, at one of three levels of external noise, and one of seven di_erent contrasts (21 stimulus conditions). Learning was assessed by measuring identification accuracy across bins of trials in each session. Consistent with earlier findings, small amounts of practice on day 1 improved performance on day 2, although more learning was obtained in the 40-trials condition (Hussain et al, 2009 Vision Research 49). Crucially, between-session learning in both conditions was stimulus-specific: performance dropped for novel stimuli regardless of whether observers received 40 or 5 trials per condition on day 1. These results suggest that, at least for some tasks, a relatively small number of trials is su_cient to produce perceptual learning that is stimulus specific.
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Mental imagery learning improves motion direction discrimination

E M Tartaglia[1], L Bamert[2,1], M H Herzog[1], F W Mast[3] ([1]Laboratory of Psychophysics, Brain Mind Institute, École Polytechnique Fédérale de Lausanne (EPFL), Switzerland; [2]Institut de Psychologie, Université de Lausanne, Switzerland; [3]Dept of Psychology, University of Bern, Switzerland; e-mail: elisa.tartaglia@epfl.ch)
Every-day life situations require the ability to anticipate trajectories of objects. It is debated to which extent top-down processes, eg mental imagery, are involved in these tasks. Here, we investigated the role of mental imagery on motion perception using perceptual learning. We presented a blank screen and asked observers to imagine dots moving coherently to the right or to the left. Imagery training lowered motion direction thresholds as determined in pre- and post-baseline measurements. In line with very recent results, we show that top-down processes, as mental imagery, play a much more important role in visual information processing than previously thought.
[Pro*Doc]

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Computational modeling of the degradation of visual working memory

M Pelko[1], G Repovš[2] ([1]Slovenia; [2]Dept of Psychology, Faculty of Arts, University of Ljubljana, Slovenia; e-mail: mpelko@gmail.com)
Working memory is a system enabling temporary maintenance and processing of information. The sustained firing of neurons observed in neuropsychological experiments in monkeys is thought to represent the neuronal correlate of the maintenance of representations in working memory. Two mechanisms have been proposed to explain the short duration and degradation of working memory—temporal decay and interference [Portrat et al, 2008 J Exp Psychol Learn Mem Cogn 34(6) 1561-1564; Oberauer et al, 2008 Psychological Review 115(3) 544-576]. To gain further insight into possible underlying neuronal mechanisms of the temporal degradation of working memory we conducted a computer simulation of the memory-guided saccade task that has shown stable accuracy, but decreased precision of saccades with increasing working-memory delay both in humans [Ploner et al, 1998 The European Journal of Neuroscience 10(2) 794-797] and monkeys (White and Snyders, 2005 SFN Annual Meeting). We employed the prefrontal cortex network model for spatial working memory [Compte et al, 2000 Cerebral Cortex 10(9) 910-923] to explore the network and single cell behavior of the model in such experiments. By comparing the model behavior throughout a wide parameter space with the results of behavioral studies and in vivo single-cell experiments we hope to test the ability of the model to capture the observed degradation of working memory and by that confront and compare the two proposed

mechanism of degradation.

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E_ects of education and gender on preferential di_erence to shapes and colour

L K F Tey (Defence Medical & Environmental Research Institute, DSO National Laboratories, Singapore; e-mail: tliankhe@dso.org.sg)

This project aimed to determine if preferential di_erence exists for students from di_erent education background using colour and shapes as stimuli where reaction time and accuracy with inverse e_ciency (IE) given by RT/accuracy [Csatho et al, 2008 Cognitive Neuropsychology 25(7) 1039-1064] were used as the standard composite measure. 96 students (32 students from engineering, science, and business, respectively, with equal gender from each school) were tasked to press one of the four encoded keys as quickly and accurately as possible following exposure to a question. The participants were asked to fill in the STAI (Spielberger et al, 1983, in Manual for the State-trait Anxiety Inventory Consulting Psychologists Press, Palo Alto, CA) and POMS surveys to determine their state, trait anxiety and mood. Results showed a significant e_ect of school in terms of inverse e_ciency scores where business students consistently outperformed science and engineering students. Gender di_erence and trait anxiety did not have a significant e_ect on inverse e_ciency scores while low state individuals outperformed high state individuals. Mood was not a confounder that a_ected their IE scores. Individuals tend to react slower to most preferred stimuli and were quicker to react to stimuli of least preference.

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Characteristics of visuomotor sequential learning in ADHD and Asperger syndrome

H Ikeda[1,2], M Miyao[3], K Watanabe[1,4] ([1]Research Center for Advanced Science & Technology, University of Tokyo, Japan; [2]Research Fellowship for Young Scientists, JSPS, Japan; [3]Dept of Development & Behavioral Pediatrics, National Center for Child Health and Development, Japan; [4]HSBE, AIST, Japan; e-mail: hikeda@fennel.rcast.u-tokyo.ac.jp)

Developmental disorders such as attention-deficit/hyperactivity disorder (ADHD) and Asperger syndrome (AS) are often associated with learning disabilities [Nicolson and Fawcett, 2007 Trends

in Neurosciences 30(4) 135-141]. Furthermore, the execution of skilled movements deficits are reported in various developmental disorders. This study investigated how ADHD children, AS children, and typically developing children would acquire explicit visuomotor sequences. In a sequential button-press task [2×10 task: Hikosaka et al, 1996 Journal of Neurophysiology 76(1) 617-621], participants learned to press 2 out of 16 LED buttons in correct order. Ten di_erent pairs were presented in a fixed order. Participants were required to explore a hidden sequence and learned the sequence by trial and error. The results indicated that although ADHD and AS children tended to repeat the same errors and take longer to complete a sequence, both showed a degree and pattern of improvement in accuracy and speed similar to those of typically developing children. These results suggest that, although execution of motor skills is seemingly impaired in ADHD and AS children in everyday situations (eg, in class room), the explicit learning process of visuomotor sequence in ADHD and AS patients may actually be unimpaired.

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Influence of training on the interpretation of optic flow and extramarital egomotion signals for structure-from-motion

A Jain, B T Backus (Graduate Center for Vision Research, SUNY College of Optometry, USA; e-mail: anshuljjain@gmail.com)

Optic flow (Wallach and O'Connell, 1953 Journal of Experimental Psychology 45 205-217), a potent 3D-shape cue, can be generated either by observer motion or object motion. A rotating object and its counter-rotating depth-inverted dual generate similar flow. Wexler et al [2001 Nature 409(6816) 85-88] showed that flow caused by egomotion is perceived more often as the dual that is stationary in an allocentric frame of reference (rather than the dual that rotates). We replicated this finding and examined whether this stationarity bias is modulated by experience. During 'training', subjects (two groups) were exposed to either stationary or moving objects, as specified by disambiguating cues. We found a di_erential preference for stationarity on ambiguous test trials that was consistent with the training. We further examined whether di_erent biases can exist at di_erent locations in the visual field. Subjects were trained to see objects as stationary or moving at two locations (above or below fixation). We found a di_erential preference for stationarity that was consistent with the training and a di_erential bias to perceive objects above fixation as moving. Thus, the disambiguation of retinal optic flow signals by extramarital egomotion signals is dynamic and reflects the current environmental statistics, consistent with experience-dependent updating of a Bayesian prior.

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Practice e_ects in acuity testing
S P Heinrich, K Krüger, M Bach (Universitäts-Augenklinik, Albert-Ludwigs-Universität Freiburg, Germany; e-mail: sven.heinrich@uniklinik-freiburg.de)
So far, practice e_ects in acuity testing have only received scant attention, despite a wide range of studies demonstrating practice e_ects for other visual tasks. In the present study, subjects completed a total of 56 test runs of a computer-based acuity test with randomly oriented Landolt C optotypes, split evenly over 4 sessions at intervals of one week. Some of the subjects received feedback indicating the correct response. Between the first and the last session, acuity increased significantly by −0.112 logMAR with feedback and by −0.055 logMAR without feedback. With feedback, some increase occurred over the first few runs of the first session, but the most prominent run-by-run increment took place between the last run of the first session and the first run of the second session. Without feedback, the practice e_ect occurred mainly within the first half of the first session. Despite acuity presumably being in constant training in normal life, our results show that it is susceptible to specific practice. Even without feedback, this may become relevant in clinical acuity exams in cases of repeated testing, for instance in study patients. The strong increase in between the sessions with feedback hints towards a role for cognitive consolidation.
[Supported by the Deutsche Forschungsgemeinschaft]

POSTER SESSION: MODELS AND THEORY

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A simple neural model for the processing of global and local face information
H R Bliem (Dept of Psychology, University of Innsbruck, Austria;
e-mail: Harald.R.Bliem@uibk.ac.at)
A neural model of how face-specific information might be processed on the subcortical and cortical level is proposed. Based on the well known properties of the magnocellular and the parvocellular visual systems (Livingstone and Hubel, 1987 Journal of Neuroscience 7 3416-3468) it reveals the importance of the magno-supported processing of global (configurational) information and the parvosupported processing of local (detailed) information from low to high level vision. These main pathways with forward and lateral connections including inhibitory interactions in high level cortical areas are represented as important for face recognition and face-specific working memory activity. Furthermore the model incorporates some important aspects of global and local perceptual processes, eg their interaction and reveals change of perceptual strategies with face recognition. Compared to the well known functional model for face recognition by Bruce and Young (1986 British Journal of Psychology 77 305-327) the proposed neural model can be regarded as a first schematic microgenetic split-up of face modules in the human brain. Hence it explains how defective magno-supported information processing may underlie neurocognitive impairments in configurational apperceptive prosopagnosia (Bliem, 2003 Journal of Cognitive Neuroscience CNS Supplement, 189) and probably in other social-cognitive diseases signified by global face processing deficits.

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Non-parametric adaptive visual psychometry
T Elze, S Poppe (Group: Comlex Structures in Biology and Cognition, Max Planck Inst. for Mathematics in the Sciences, Leipzig, Germany; e-mail: Tobias.Elze@mis.mpg.de)
Psychometric functions describe relations between parameters of a stimulus and responses of observers. In many fields of vision science such psychometric functions are popular, for instance to characterize luminance or color perception or to study spatial or temporal characteristics of vision. In psychophysical experiments it is usually not possible to collect large numbers of data as data acquisition might be expensive or observers might get tired or learn too quickly. Therefore, several adaptive measurement procedures have been proposed. In an adaptive procedure, subsequent samples are measured at those stimulus parameter values which promise the optimal gain of information about the underlying function course considering all prior samples. Typically, adaptive procedures assume function families such as sigmoidals which have only a small number of parameters which implies strong assumptions about the underlying psychometric function. In several areas of vision science, however, the underlying functions are unknown and no commonly accepted models exist for them, such as in temporal vision. Here, we propose a non-parametric adaptive measurement procedure. It is based on the concept of exchangeability and exploits the weak assumption that neighboring measurement points should be related. We demonstrate the power of this concept by simulations and exemplary psychophysical experiments.

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A two stage model for perceptual decision making
N Marcille[1], J Rüter[2], M H Herzog[2], W Gerstner[1] ([1]Laboratory of Computational Neuroscience, École Polytechnique Fédérale de Lausanne (EPFL), Switzerland; [2]Laboratory of Psychophysics,

Brain Mind Institute, École Polytechnique Fédérale de Lausanne (EPFL), Switzerland;
e-mail: nicolas.marcille@epfl.ch)
Reaction times of decision making are generally modeled by drift di_usion models, in which sensory input is accumulated over time. A decision is made when evidence hits a threshold. Most models use constant sensory input and a constant drift value of the di_usion process. Hence, sensory input and drift are directly linked. Here, we used a feature fusion paradigm to investigate how time varying input is integrated in humans. In feature fusion, features of two stimuli presented in rapid succession fuse into one single percept, eg a yellow disk is perceived when a red disk is followed by a green disk. Response times for the first stimulus were not shorter than for the second stimulus. Yet, the second stimulus dominates the percept. These results cannot be explained by models which directly link input and drift. We propose a new two-stage model in which the drift is not driven by the input directly but by the output of a preliminary sensory integration process.
Poster session: Models and theory
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Principles in the computational modelling of eye-movements in reading
R C Shillcock[1,2], M A J Roberts[2], H Kreiner[3], M Obregón[2], P Monaghan[4] ([1]Informatics, University of Edinburgh, UK; [2]Psychology, University of Edinburgh, UK; [3]Behavioral Sciences, Ruppin Academic Centre, Israel; [4]Dept of Psychology, University of Lancaster, UK;
e-mail: rcs@inf.ed.ac.uk)
We take computational models of eye-movements in reading and consider the philosophical status of their components, specifically the visual input—the models' eyes. We distinguish between an 'abstract universal', defined as that which is common across a range of instances, and a 'concrete universal', defined as an abstract, but still objective aspect of the process of reading. We argue that models composed exclusively of abstract universals cannot be the basis for a sustainable, scientific investigation of reading. In contrast, the concrete universal in a model mediates the whole of the domain, interacting in necessary ways with the other components of the domain. Unlike the abstract universal, the concrete universal cannot be defeated by new data. The modelling enterprise becomes one in which the goal is completeness rather than simplicity, and explanation is found in the double-movement of analysis down to the abstraction of the concrete universal and synthesis up to the concrete of the full complexity of the reading system.We argue for the space-text-and-reader (STAR) principle: the precise spatial relationship (x, y, and z coordinates) between the plane of the text and the reader is the 'concrete universal' in reading.
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The improved model of the eye optical system
A Batvinionak[1], A Kirpichnikov[2] ([1]Physics of Live Systems Departament, Moscow Institute of Physics and Technology, Russia; [2]Institute of Control Sciences, Russian Academy of Sciences, Russia; e-mail: tigrolga@bk.ru)
The classic models of the eye optical system used for explaining the results of physiological, psychophysical, and psychological experiments are not precise enough for a detailed study of perception. The proposed optical model considers the eye asa multifocal system with intricately shaped 3D-surface and the optimal image quality that emerges as a result of the accommodation process. In contrast to the classic models, not only the cornea and crystalline lens, but also all the optical media in the eye are taken into account (wherever refraction gradient are present). The vitreous body is considered to be an adjustable part of the system, controlled by muscle mechanical force and liquid pressure. For applications of the accommodation theory, it is important that the vitreous body optical power acts jointly with the crystalline lens power in determining the accommodation state. The results of our physiological experiments and participation at eye surgeries allow us to make an estimation (in vivo) of some of the parameters used (viscosity, etc.). Our model takes the dynamic processes into account and allows adjustment of a broad range of parameters, making it suitable for practical tasks.
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Multiple-object tracking in a neural network for visual working memory
M Setic, D Domijan (Dept of Psychology, University of Rijeka, Croatia (Hrvatska);
e-mail: mia-setic@_ri.hr)
We proposed a recurrent neural network for visual working memory which is able to track objects as they move in the visual field. The model is based on queuing networks previously used in neural models of serial order in working memory. The proposed model consists of self-excitation and two types of inhibition: recurrent (or lateral) and dendritic inhibition. The model explicates how pointers to di_erent objects are labeled with di_erent activity levels and how this activation is updated as objects move in space. Computer simulations showed that the capacity to track objects is limited due to the lateral inhibition and to the restricted dynamic range of model neurons. However, capacity could be dynamically modulated by the object's speed. Self-excitation enables tracking of objects which disappear

and reappear behind visible or invisible occluded surfaces. When moving objects form a perceptual group, the capacity to track objects increased due to weak lateral inhibition among the members of the group. On the other hand, the model showed reduced capacity to track substances which extends in space as they move. Therefore, the model provides unified account of variability in capacity for multi-object tracking.
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Spatial structure of transitory apparent contrast
G J van Tonder (Laboratory of Visual Psychology, Kyoto Institute of Technology, Japan;
e-mail: gvtonder@yahoo.co.uk)
Transitory apparent contrast is a perceptual phenomenon in which vivid illusory patterns of high contrast appear to fluctuate within periodic line images, as first described by (Purkinje, 1825 Magazin für die gesamte Heilkunde 20 199-276) (see http://www.cis.kit.ac.jp/_gert/ecvp2010.html). Since then, this perceptual e_ect has mainly been attributed to preretinal (astigmatism), retinal/low-level vision (photoreceptors, ganglia, motion-detectors) or high-level vision mechanisms (for a good review, see Gosselin and Lamontagne, 1997 Perception 26 847-855)), but its theoretical underpinnings and neural origins remain unresolved. Here, I show that local alignment of stimulus structure and relative displacement vectors predict the spatial structure of perceived high contrast patterns. A model of visual transduction in retinal cones—a potentially low-level neural model—both confirms the theory and specifically indicates where and why theoretical prediction deviates from actual percepts. These findings consolidate various observed 'illusions' under a unified interpretation. Some new perceptual e_ects are demonstrated to be accurately predicted by the computational models. Perhaps the most counter-intuitive aspect of this study is the insight that the apparently highly dynamic contrast patterns seen in line images actually occur along stimulus loci with minimal movement relative to the retina. Instead of motion detectors or other mechanisms sensitized to fast stimulus changes, these perceptual patterns are therefore primarily driven by slow retinal circuits, responding to regions of slowest stimulus change.
[The author wishes to thank Lothar Spillman and Dhanraj Vishwanath for valuable discussions]
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A neural network model of the functional neuroimaging data on perceptual grouping
D Domijan (Dept of Psychology, University of Rijeka, Croatia (Hrvatska);
e-mail: ddomijan@_ri.hr)
A neural network is proposed to explain how di_erent patterns of brain activations arise in functional MRI during viewing of stimuli of various level of complexity. The model implements object-based selection by global inhibition applied to all background spatial locations and local excitation which enable activity spreading along the locations of the figure. It is assumed that excitatory neurotransmission along the dendritic trees provides a major contribution to the blood-oxygen-level-dependent (BOLD) signal. Computer simulations showed that increased perceptual complexity of the stimulus lead to the reduction of BOLD signal in V1. On the other hand, LOC exhibits opposite pattern with strongest BOLD activation for images with 3D interpretation. This pattern of activation is observed when there is no distractors present in the visual field. In the task of collinear contour grouping (with many distracting Gabor patches) both V1 and LOC showed elevated BOLD signal when perceptual group (contour) is present compared to the control condition. Also, the model explicated how attention contributes to the perceptual grouping through di_erential neural activations in parietal cortex. The proposed model is consistent with the concepts of base and incremental grouping derived from electrophysiological studies.
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Layer segmentation using hue, texture and luminance amplitude in a steerable filter framework
X Jiang[1], A J Schofield[1], J L Wyatt[2] ([1]School of Psychology, University of Birmingham, UK;
[2]School of Computer Science, University of Birmingham, UK; e-mail: x.y.jiang@bham.ac.uk)
Humans are able to di_erentiate variations in luminance due to illumination (eg shadows and shading) from those due to material properties (eg albedo). This process is sometimes referred to as layer segmentation where each layer has a distinct physical origin. Layer segmentation is recognised as a challenging, ill-posed problem in computer vision where the term 'intrinsic image extraction' is preferred. Studies of human vision have suggested a number of heuristics which may suitably constrain the layer segmentation problem (Kingdom, 2008 Vision Research 48 2090-2105). We focus on just three cues: hue, texture and local luminance amplitude (the di_erence between the light and dark parts of a texture pattern). Hue and texture tend to vary at material boundaries whereas local luminance amplitude varies with illumination. We propose a framework for layer segmentation based on steerable filters. Filtered components are weighted according to their correlations with the above cues. The weighted

components are then used to construct illumination and reflectance images. The method operates on single images without a training phase. We have tested the method with a combination of surface types
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and illumination sources; it works particularly well for shaded, randomly patterned, and smoothly undulating surfaces as found on natural objects.
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A low cost optical tool for a 3D markerless motion capture
Y P Rybarczyk (Faculty of Sciences and Technology, New University of Lisbon, Portugal;
e-mail: y.rybarczyk@fct.unl.pt)
A markerless motion capture technique is described for reconstructing three-dimensional biological motion. The process is composed by several stages. At first, an action is recorded with 2 CCD webcams. Second, the movie is divided in frames. For each frame, the 2D coordinates of key locations (body joints) are extracted by the combination of manual identification (mouse pointing) and image processing (blobs matching). Finally, an algorithm computes the x-y coordinates from each camera view to write a file containing the 3D coordinates of every visible point in the display. This technique has many advantages over other methods. It doesn't require too specialized equipment. The computer programming uses open source software. The technology is based on an inexpensive portable device. Lastly, but not least, it can be used for di_erent environments and living beings (humans or animals). By developing a low-cost and portable system, this technology has already been tested in a wide range of applications. Avatars, like point-light walkers, have been created for psychophysical studies. Since the recording is stereoscopic, it can be used in a clinical context for a deeper three-dimensional analysis of the motion (eg comparison of movement smoothness before and after a cerebral surgery or medication in parkinsonic patients).
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Reinterpretation of receptive field properties of type II parvocellular cells in the macaque LGN
T Seim[1,2], A Valberg[2], B B Lee[3] ([1]MikroSens, Norway; [2]Institute of Physics, Norwegian University of Science and Technology, Norway; [3]Institute of Biophysical Chemistry, Max Planck University, Germany; e-mail: thorstein.seim@c2i.net)
The spatial profile of cone-opponent parvocellular (PC) cells in the lateral geniculate nucleus (LGN) of the primate is usually described by a di_erence of Gaussians (DOGs) model. However, a Gaussian shaped surround sensitivity leads to an inhibitory surround with a more limited spatial influence than is suggested by experimental data. Also, DOG functions imply that the opponent excitation/inhibition ratio changes drastically with stimulus size. We have recorded the responses of ON- and OFF-parvocellular cells to stimuli of di_erent wavelengths, intensity and size. Test stimulus duration was 300 ms, alternated with a white, 4×5 deg^2, 110 cd/m^2 adaptation field of 1200 ms duration. The size of the test stimulus varied from 0.2 deg to 4×5 deg. The spatial sensitivity profile of cells with coextensive excitatory and inhibitory receptive fields (type II) clearly followed a power function. This means that the L/Msensitivity ratio of the cell was the same for all test field sizes. This result explains the fact that hue does not change much for the stimulus sizes applied here, a fact not accounted for by a DOG model. Moreover, this interpretation explains why adding a steady white annulus outside the 'classical' receptive field simply shifts the L and M intensity-response curves by the same amount.
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Estimation of value of curvature of photographic space by using a generalized projective transformation
T Watanabe (Faculty of Environment and Information Studies, Keio University, Japan;
e-mail: watanabe@sfc.keio.ac.jp)
A generalized projective transformation was proposed and used as a mapping function between physical space and photographic space. It enabled us to estimate the value of the curvature of photographic space. In an open space of 21 m in width and 40 m in depth, three objects A, B, and X were presented. Objects A and B were fixed and object X was presented at various locations (AX=4, 10, 16, 22, 28 m; angle BAX= 0, 4, 8, 12, 16, 20 degrees). Three objects were photographed from the origin. Later, subjects observed the photographs projected on the screen at 1.9 m in front of the screen. Subjects were asked to judge the ratio AX/AB and the angle BAX. Data were converted to coordinated values. Using generalized projective transformation, it was found the two dimensional photographic space was represented by the hyperbolic paraboloid and the value of the curvature was negative.
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A Gaussian derivative model of the complex cell
M Hansard, R Horaud (INRIA Rhone-Alpes, Grenoble, France;
e-mail: miles.hansard@inrialpes.fr)
It is well-established that simple cells in the primate visual cortex can be understood in terms of linear filters. These filters can be modelled by Gabor functions, or by Gaussian derivatives (Koenderink and van Doorn, 1987 Biol. Cyb 55 367-375). Gabor functions can also be combined in an energy model [Adelson and Bergen, 1985 JOSA A 2(2) 284-299] of the complex cell response. Here we propose an alternative model of the complex cell, based on Gaussian derivatives. It is most important to account for the invariance of the complex response to small shifts of the image. The new model takes a linear combination of the first N derivative filters, at a single position. This combination is made to approximate the first derivative filter, at a series of adjacent positions. The maximum response, over all positions, gives a signal that is insensitive to small shifts of the image. This model is demonstrated in 1D and 2D, including experiments on natural images. Certain advantages over the Gabor energy model are discussed, including the steerability of the new model. It is noted that the range of spatial invariance depends on the number of available derivatives, which suggests a role for the high-order filters that have been found in the primate visual cortex.

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Dynamic memory of gradually changing objects within a feedforward neural network model

A H Azizi (Dept of Physics, Institute for Advanced Studies in Basic Sciences (IASBS), Zanjan, Iran; e-mail: ah_azizi@iasbs.ac.ir)
Although our surrounding environment is gradually changing, our brain maintains an updated representation of changing objects, preserving the object identity. Preminger et al [2009 PNAS 106(13) 5371-5376)] have designed a training procedure in which a friend face transforms into an originally nonfriend face over a long timescale. After completion of the practice, the observers increasingly identified more recently encountered faces as the source face. Preminger et al used attractor neural networks with a novelty-facilitated learning protocol (Blumenfeld et al, 2006 Neuron 52 383-394) as their theoretical framework. They have shown that by choosing the right learning rate in their protocol, the location of the attractor can shift toward the target face. Instead, we have used a hierarchical and forward model of the ventral visual stream [Serre et al, 2007 PNAS 104(15) 6424-6429] and a linear classifier—the prefrontal cortex—as a readout circuit, to classify an inferotemporal representation of a face into friend/non-friend classes. Using the exact set of data they used (courtesy of S. Preminger), our results are in good agreement with their experimental results, showing that one can attribute this ability of our brain to the learning process occurring in the prefrontal cortex.

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Relative importance of sensory and motor events in reinforcement learning

O H Hamid, J Braun (Dept of Cognitive Biology, Institute of Biology, Otto-von-Guericke University Magdeburg, Germany; e-mail: hamid@ovgu.de)
Recently, we reported that consistent temporal order accelerates the concurrent learning of multiple visuomotor associations (Hamid et al, 2010 BMC Neuroscience 11 45). As both visual stimuli and rewarded motor actions followed a consistent temporal order, we could not unequivocally distinguish the relative importance of sensory and motor events. To resolve this ambiguity, we have conducted a reversal study in which we disrupted the order of events by replacing either an individual visual stimulus (visual reversal), or an individual rewarded action (motor reversal), or both (combined reversal). We found that any type of reversal reduced performance to chance, in contrast to the prediction of simple reinforcement models. Recovery speed depended on the altered type of event and was faster for a visual reversal than for a motor reversal or a combined reversal. Compounding a visual reversal with an additional change in the previous trial also revealed the unequal importance of di_erent types of temporal context: performance recovered more rapidly when the previous motor response, rather than the previous visual stimulus, was retained. We conclude that, although both sensory and motor contexts facilitate associative learning in our paradigm, the dominant factor, however, is the context provided by rewarded motor responses.

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Night vision in barn owls: visual resolution under dark adaptation

J Orlowski, W M Harmening, H Wagner (Dept of Zoology and Animal Physiology, RWTH Aachen University, Germany; e-mail: Julius.Orlowski@rwth-aachen.de)
The frontally oriented eyes of barn owls are known to have excellent optical quality. However, in previous behavioral studies, maximum contrast sensitivity was found to be below 20, and visual acuity was determined to be quite poor (4 cycles per degree) in these animals. This places barn owls at the

very low end of the avian acuity and contrast sensitivity spectrum. Considered alone, these findings do not warrant optics of excellent quality. On the other hand, in low light conditions, it may be beneficial to have optics with few aberrations, to yield the highest information gain and retain as much visual acuity as possible. In the current study the visual acuity of 3 barn owls was determined at 9 di_erent luminance conditions, ranging from photopic (3 cd/m2) to fully scotopic (1.2×10^{-7} cd/m2) illumination. The absolute sensitivity threshold was determined in a set of psychophysical experiments. Absolute detection threshold was estimated to be 6.43×10^{-7} cd/m2, a value comparable to other nocturnal species. The peak grating acuity was at mesopic (3.8×10^{-2} cd/m2) conditions. Barn owls retained a quarter of their maximal spatial acuity when luminance was decreased by 5.5 log units, a feat of remarkable nocturnal adaptation.

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Visual temporal integration on object recognition in chimpanzees and humans

T Imura (Primate Research Institute, Kyoto University, Japan; e-mail: imura@pri.kyoto-u.ac.jp)

According to observations of wild and captive chimpanzees, individuals seem to be able to recognize an object partly occluded by obstacles (eg tree branches). Such competence should be related with the ability to integrate local fragmented visual features into a complete image. However, some studies report that chimpanzees often show di_culty when trying to convert these partial visual features. This study examined dynamic shape integration, using four chimpanzees and eight humans. A line drawing that represents an object was moved behind a slit (6, 18, or 30 pixels in width) at either a slow or fast speed, followed by three line drawings presented on a monitor screen. One of the three drawings was identical to a drawing that previously moved behind the slit. The task was to choose this same drawing amongst the three alternatives. Results indicated that humans had high accuracy in all speeds and in all slit-width conditions. In contrast, with chimpanzees, the rate of correct responses decreased during the high speed or the narrowest slit conditions. These findings suggest that chimpanzees are able to recognize an object by integrating a fragment into a complete image, but their ability to do so is quantitatively di_erent from humans.

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Locking of spiking and LFP activity to video monitor refresh in tree shrew primary visual cortex

J Veit, A Bhattacharyya, R Kretz, G Rainer (Visual Cognition Laboratory, University of Fribourg, Switzerland; e-mail: julia.veit@unifr.ch)

Tree shrews are day-active mammals with a well developed visual system, and are close relatives of primates. Here we characterize neural responses in the primary visual cortex (V1) of the anesthetized tree shrew to stimuli presented on a cathode ray tube (CRT) video monitor. We recorded spiking and local field potential responses to visual stimuli using tetrodes in di_erent V1 layers at monitor refresh rates of 60, 90, and 120 Hz. Here we present data from sparse noise and white noise stimuli that are used to characterize V1 spatiotemporal receptive fields. We have preliminary data from 42 recording sites in 5 animals. We find strong locking of spiking and LFP responses to the monitor refresh. Entrainment of neural responses was present at all refresh rates, but was strongest at 60 Hz. Entrainment was stronger for high contrast stimuli, and greater for luminance decrements than increments compared to the background. Our findings suggest greater locking of V1 neural responses in tree shrews than in primates, and provide information on the temporal characteristics of tree shrew V1 of importance in experimental design and data interpretation.

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Saccade-like global spatial-integration processes in a hand-pointing task in baboons

F Vitu, J Fagot (Laboratoire de Psychologie Cognitive, CNRS, Université de Provence, France; e-mail: Francoise.Vitu-Thibault@univ-provence.fr)

When a peripheral saccade-target object is presented simultaneously with one or several distractor(s), the eyes first move towards the centre of gravity of the global visual configuration (Findlay, 1982 Vision Research 22 1033-1045). This e_ect, which reflects early spatial-integration processes at the

level of the superior colliculus, reduces with increasing saccade latency or when detailed visual-cortical information becomes available. Here, we investigated the presence and time course of a global e_ect in hand movements, which show greater latency ranges. Four Guinea baboons (Papio papio) were trained to perform a hand-pointing task. On each trial, a target (a 6°-diameter circle) was presented at a variable eccentricity (20 vs 30°) from a previously-displayed initial pointing stimulus (a cross), with or without a 10-degree less or more eccentric distractor (a square). In the no-distractor condition, baboons' hands slightly undershot the centre of the target. In the distractor condition, hand-pointing responses, though remaining within the target area, were greatly deviated towards the inner or the outer distractor, and this for movement-latencies up to about 500–550 ms. Thus, global spatial-integration processes also influence hand movements. Their rather long duration may reflect limitations in the extraction of

stimulus-location information in baboons or alternatively the unavailability of this information to the motor system.

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Pointing with a stick does not alter judged distances

D D J de Grave, E Brenner, J B J Smeets (Human Movement Sciences, Vrije Universiteit Amsterdam, The Netherlands; e-mail: d.degrave@fbw.vu.nl)

The judged distance one can reach (judged reachability) has been reported to be increased after a stick has been used. Furthermore, an object is judged to be closer when a stick is used to point at the object compared to when pointing is performed with the hand. In this study we try to confirm whether pointing with a stick a_ects judged distances. To do so, we show subjects a cylindrical object on a table. In each trial, subjects either estimate how far the object is away from their body (in cm) or they point to a location halfway between the object and the starting position of their hand. In one block of trials they point with their finger and in another block they point with a stick. No di_erences in verbal distance judgments are found when pointing is done with a stick or with the hand. The position to which subjects pointed is also not changed by pointing with a stick. We conclude that pointing with a stick does not alter judged distances of objects.

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Rich 3D environments facilitate sensorimotor learning

J-P Bresciani[1], J Tesch[1], H Bischo_[1], H H Bültho_[1,2] ([1]Dept of Human Perception, Cognition and Action, Max Planck Institute for Biological Cybernetics, Tübingen, Germany; [2]Dept of Brain and Cognitive Engineering, Korea University, South Korea; e-mail: bresciani@tuebingen.mpg.de)

Using a visuo-vestibular adaptation paradigm, we measured how the richness/realism of the visual scene a_ects sensorimotor learning. Participants seating on a motorized wheelchair had to maintain their stretched arm fixed in space despite whole-body rotations. After a test session in which body rotations occurred without visual information, participants were exposed to a visuo-vestibular adaptation, and then tested again in a test session identical to the first one. In the adaptation phase, biased visual information about motion amplitude was provided during body rotations via a head-mounted display, so that participants learned a biased visuo-vestibular mapping. Four di_erent types of adaptation were used (with di_erent participants). Specifically, we manipulated orthogonally the visual information relative to the own body (avatar arm vs sphere indicating fingertip position) and that relative to the surrounding environment (virtual room vs sphere). All four types of visual environments gave rise to a significant adaptation ($p<0.05$). Interestingly, the amplitude of the adaptation (both relative and absolute) was significantly larger only when the room and the arm were realistically displayed. These results suggest that for a sensorimotor learning facilitation to occur, both body-related and environment-related visual information must be realistic.

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Evidence for anisotropic e_ect of visuomotor adaptation on the perception of peripersonal space

J Bourgeois, Y Coello (URECA, Université Lille Nord de France, France; e-mail: jeremy.bourgeois@univ-lille3.fr)

Recent studies have highlighted the role of motor representation in perceptual processes. In the present study, we evaluated the isotropic e_ect of visuomotor adaptation on spatial perception. Two groups of participants performed a reachability judgment task after having performed a set of pointing movements. In the latter task, terminal feedback about spatial performance was gradually shifted by 1.5 cm in each of the six sessions of 60 trials, up to a 7.5 cm bias in the final session. Depending on the bias direction, a visuomotor adaptation was required either in hypometry (decrease of movement amplitude for similar

spatial accuracy) or in hypermetry (increase of movement amplitude for similar spatial accuracy). Results showed that perceived boundary of reachable space changed according to visuomotor adaption, but only in the hypermetry condition. This asymmetry suggests anisotropic e_ect of visuomotor adaptation on spatial perception.

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Egocentric distance judgments in a large-screen immersive display virtual environment

I V Alexandrova[1,2], P T Teneva[1,3], U Kloos[2], H H Bültho_[1], B J Mohler[1] ([1]Dept of Human Perception, Cognition and Action, Max Planck Institute for Biological Cybernetics, Tübingen, Germany; [2]Media and Communication Informatics, Reutlingen University, Germany; [3]Computational Linguistics, Eberhard Karls University, Tübingen, Germany; e-mail: ivaalexandrova@yahoo.com)

People underestimate egocentric distances in head-mounted display virtual environments (VEs) as

compared to the real world. In a recent study (Riecke et al, 2009 APGV 15-18) it was shown that when a person viewed a photorealistic world through an HMD or a large screen display (while sitting and not moving their head) they did not underestimate egocentric distances. We further investigate whether people underestimate egocentric distances in a large screen immersive display. In our experiment, participants were asked to report verbal estimates of egocentric distances in a large screen display with floor projection or in the real world. Overall, in the virtual world we found an underestimation of distances by 17% as compared to near accurate performance in the real world. Moreover, in the virtual world there was an e_ect of distance, which indicated overestimation for distances that occurred before the screen (3.5 meters), while for distances past the physical screen there was underestimation. To determine the full reason for these e_ects further analysis is needed. Our results demonstrate that egocentric distance judgments are also underestimated in a large screen immersive display as compared to the real world.

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The impact of an animated avatar on egocentric distance perception in animmersive virtual environment

B J Mohler[1], S H Creem-Regehr[2], W B Thompson[3], H H Bülthoff[1] ([1]Dept of Human Perception, Cognition and Action, Max Planck Institute for Biological Cybernetics, Tübingen, Germany; [2]Dept of Psychology, University of Utah, USA; [3]School of Computing, University of Utah, USA; e-mail: betty.mohler@tuebingen.mpg.de)

To date, few head-mounted display (HMD) virtual environment systems display a rendering of the user's own body. Subjectively, this often leads to a sense of disembodiment in the VE. In a recent study, we found that the experience with a self-avatar changed the typical pattern of distance underestimation seen in many HMD studies (Mohler et al, in press Presence). Users showed an increase in distance estimations with avatar experience, especially when the avatar was animated in correspondence with their own body-movements. The e_ect occurred for both co-located self-avatars and self-avatars viewed from the third person perspective. The current study investigated the importance of the degree to which self-avatar animation reflected the actual movements of the user. We compared distance judgments with a third-person perspective view of a self-avatar that was either controlled by user motions or was animated based on pre-recorded motion data. The results suggest that experience with an animated avatar, even if not in correspondence with a user's own body movements, increases distance estimates. The magnitude of this e_ect will be further examined with additional participants.

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Reaching movement accuracy is mainly determined by visual online control

H Bruggeman[1,2], C Fantoni[1], C Caudek[3], F Domini[1,2] ([1]Center for Neuroscience and Cognitive Systems, Italian Institute of Technology, Italy; [2]Dept of Cognitive and Linguistic Sciences, Brown University, USA; [3]Dept of Psychology, University of Florence, Italy; e-mail: hugo@brown.edu)

Here we demonstrate that the accuracy of reaching a target is a_ected by neither the representation of the target location nor the visual feedback provided up to 250ms before movement completion. Observers performed reach-to-point movements for a real cylinder positioned at variable locations. We manipulated the visual information (monocular/binocular) provided in two contiguous segments. Main segment: trajectory from the movement start up to 250 ms before movement completion. Final segment: trajectory during the final 250 ms to reach the target. The accuracy of the end position (z-depth) of the reaching movement was measured. We found reliable e_ects of visual information sampled during the final segment, but not during the main segment. Reaching was accurate if disparity information was provided throughout the whole movement or only in the last 250 ms segment. Overshooting of 1 cm was found when disparity information was absent during the whole movement or in the last 250 ms segment.

The latter is surprising, as the target appeared binocular for most of the movement duration allowing for ample time to plan the movement-end. Thus, accuracy in reaching performance can be explained by nulling the relative disparity between the finger and the target. Our results indicate the importance of the online component of visual-motor control.

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Path planning in economic terrains: Heuristics and optimization

H Zhang[1,2], S V Maddula[1], L T Maloney[1,2] ([1]Dept of Psychology, New York University, USA; [2]Center for Neural Science, New York University, USA; e-mail: hang.zhang@nyu.edu)

We designed a simple path planning task to investigate visual decision making. On a touch screen subjects moved their finger from a starting point to a destination. They could choose any path. Their path may run across two kinds of terrain, field and desert. One unit of distance traveled in the desert cost C times more than in the field. On each trial, subjects won a fixed sum of money minus the cost of their path. Methods: A 32-inch ELO touchscreen was used. We compared performance on five di_erent spatial configurations with deserts symmetrical about a horizontal line. We examined two cost ratios

C (3 or 5) for each of the five spatial configurations. Twelve naïve subjects participated. Results: We computed measures of e_ciency (how close subjects came to winning the maximum possible) and compared subjects' paths to those expected if their planning conformed to heuristics such as "only change direction when changing terrain", etc. Subjects' e_ciency ranged from 54% to 106% with one third of subjects indistinguishable from optimal. We discuss their conformity to heuristics. We also model subjects' paths in terms of utility distortion as an alternative to heuristics.

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Catching marshmallows for science: The role of action targets in action-specific perception

R Cañal-Bruland[1], J van der Kamp[1,2] ([1]Faculty of Human Movement Sciences, VU University Amsterdam, The Netherlands; [2]Institute of Human Performance, University of Hong Kong, China; e-mail: r.bruland@fbw.vu.nl)

How we visually perceive the world is not only determined by optical information, but also by performance-related factors. For example, baseball players who hit the ball more often judge the ball to be bigger than their less successful counterparts. This phenomenon, labelled action-specific perception, supports one of the main tenets of embodied perception that performance capabilities moderate an actor's perception of the environment. Yet, the processes that mediate action-specific e_ects are largely unknown. To examine the processes underwriting action-specific perception, we used a 'Schokokuss-Wurf-Maschine' where children throw a ball at a target, which if hit successfully, launches a ball (typically a chocolate marshmallow) that the children then have to catch. In two experiments, children performed a throwing-and-catching task or a throwing-only task in which no ball was launched. After each task, the size of the target or ball was estimated. Results indicate that action-specific e_ects on perceived size only occur for objects that are related to the end goal of the action, but not for objects that are related to intermediate action goals. These results provide evidence to suggest that action-specific influences on perception are contingent upon the primary action goals to be achieved.

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Action context in motorvisual impairment and facilitation

R Thomaschke[1,2], B Hopkins[2], R C Miall[3], A Kiesel[1] ([1]Dept of Psychology, University of Würzburg, Germany; [2]Dept of Psychology, University of Lancaster, UK; [3]School of Psychology, University of Birmingham, UK; e-mail: thomaschke@psychologie.uni-wuerzburg.de)

Previous research has shown that actions impair the perception of symbolically compatible stimuli, but facilitate the perception of spatially compatible stimuli. We propose that the motorvisual impairment e_ect is due to action planning, while the motorvisual facilitation e_ect is due to action control. As planning processes action context, while control is relatively independent of context, we hypothesized that motorvisual impairment e_ects are influenced by modulations of task context, while motorvisual facilitation e_ects are not. We conducted two dual-task experiments. In one experiment, key presses impaired participants' discrimination of symbolically action-compatible stimuli (eg, perception of a left pointing arrow was impaired during a left key press). In the second experiment, key presses impaired participants' discrimination of spatially action compatible stimuli (eg perception of a symbol in the left visual field was impaired during a left key press). These results confirm previous findings. We then modulated the action context by cuing the key presses via di_erent tone-key assignments. As predicted by our hypothesis, context modulation a_ected the motorvisual impairment e_ect, but not the motorvisual facilitation e_ect. Implications for theories of motorvisual interaction are discussed.

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Doing, seeing or both: e_ects of learning condition on subsequent action perception

A J Wiggett, M Hudson, A H Cli_ord, S P Tipper, P E Downing (School of Psychology, Bangor University, UK; e-mail: a.wiggett@bangor.ac.uk)

Theories of associative learning suggest that simultaneous visual/motor experience is key to forming multimodal representations of actions. We investigated whether having correlated sensorimotor experience (motor and visual input) during learning, compared to only motor or only visual experience, leads to a greater involvement of 'mirror systems' when watching somebody else perform the previously learned actions. Participants were trained to perform novel hand actions that were learned under three conditions: (i) 'both' condition: participants performed the actions while also having a live view of their hand; (ii) 'motor only': participants performed the action but could not see their hand; (iii) 'view only': participants watched pre-recorded movies of the actions. Participants then passively viewed all types of actions (plus novel actions) from an allocentric perspective while being scanned with fMRI. Parietal and frontal regions were significantly modulated by learning condition whereas posterior (visual) areas were not. Furthermore, the 'both' and 'motor only' conditions resulted in similar frontal and parietal activations. We conclude that having motor experience during this type of learning seems to be su_cient for later 'mirror system' involvement. However, there may be an additional benefit from having concurrent motor and visual input.

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Task-irrelevant simple auditory feedback can reinforce saccadic eye movements
H Ogawa[1,2], K Watanabe[3,4] ([1]Graduate School of Human and Environmental Sciences, Kyoto University, Japan; [2]Young Researcher Development Center, Kyoto University, Japan; [3]Research Center for Advanced Science & Technology, University of Tokyo, Japan; [4]Cognition and Action Research Group, AIST, Japan; e-mail: ogawa@fennel.rcast.u-tokyo.ac.jp)
Does a mere sensory stimulation act as a reward and facilitate our behavior even when it is irrelevant to the task and performance? We addressed this question in a simple saccade task. Subjects made a saccade to a target presented at one of four locations as quickly as possible. Immediately after the saccade, an auditory tone notified the subjects that the current trial was done. The tone was irrelevant to the task and not related to saccade performance. In one block, only one fixed position was associated with the tone (one-direction-feedback: 1DF). In the other condition, three positions were associated with the tone (three-directions-feedback: 3DF). As a control condition, we also conducted one block where no feedback tone was given. The results showed that, irrespective of the feedback conditions, the mean peak velocity was higher in saccade directed to the target positions associated with the task-irrelevant feedback tone. The saccade amplitude and latency were not a_ected by the feedback. These results suggest that a task-irrelevant but response-contingent sensory stimulation can act as a reward and modulate the dynamics of saccades.
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Covert actions and the perceived boundaries of peripersonal space in children
A Richez, Y Coello (URECA, Université Lille 3 - Nord de France, France;
e-mail: richez.aurelien@yahoo.fr)
Hundred of years of theories about perception-action interactions suggest that visuospatial perception may be influenced by motor representation. This implies perceptual information to be coded in motor terms as well as a predictive model associated with action program to be used to anticipate the expected dynamic of the body in relation to the environment. Those motor predictions would be the process subtending spatial categorisation. In this context we assessed for 6-to-12 years old children the ability to perceive what is reachable as well as their abilities to perform mental simulation of motor actions: we measured to do so the correlation between execution and simulation time of parameterised movements. Analysis revealed significant e_ect of age on both performances: Children about 8 years become more accurate in determining what is reachable as well as they start to improve their capacities to accurately simulate movement. Those findings suggest: (1) a developmental aspect of children's capacities to integrate motor properties and visual information; (2) a refinement of internal models and action prediction during childhood leading to an improvement in perceptual judgment of reachability.
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Poster session: Perception and action I
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Whole-brain fMRI using repetition suppression between action and perception reveals cortical areas with mirror neuron properties
F Schillinger[1], S de la Rosa[1], J Schultz[1], K Uludag[2] ([1]Dept of Human Perception, Cognition and Action, Max Planck Institute for Biological Cybernetics, Tübingen, Germany; [2]High-Field Magnetic Resonance Center, Max Planck Institute for Biological Cybernetics, Germany;
e-mail: Frieder.Schillinger@Tuebingen.MPG.de)
Mirror neurons (MN) have been suggested to be the supporting neural mechanism for action recognition and understanding. However, there is a current debate about the localization of MNin humans. Functional magnetic resonance imaging (fMRI) studies using repetition suppression (RS) paradigms for the identification of MN provide mixed results. Studies supporting the existence of MN restricted their analysis to a-priori candidate regions, whereas studies that failed to find evidence used nonobjectdirected actions. In the present fMRI study, we tackled these limitations by using object-directed actions in a RS paradigm and performing a whole-brain analysis. Subjects observed and executed simple grasping movements di_ering only in their goal-directness (grasping a button vs grasping beside it). MN areas should be (1) more activated by goal-directed actions and (2) exhibit RS between execution and observation of the same action. The analysis revealed three significant cortical clusters in the right anterior intraparietal sulcus (aIPS), right primary somatosensory cortex and left premotor cortex that show these characteristics. While the aIPS has been reported before as a possible region for MN, the other two clusters have yet not been associated with MN directly using RS paradigms. We discuss the potential contribution of these regions to object-directed actions.
Talk session: Eye movements
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Tuesday
TALK SESSION: EYE MOVEMENTS

m Spatial specificity of the remapped BOLD response across saccades

J V Schwarzbach[1,2], A Lingnau[1], D P Melcher[1,2] ([1]Center for Mind/Brain Science, University of Trento, Italy; [2]Dept of Cognitive Science and Education, University of Trento, Italy; e-mail: jens.schwarzbach@unitn.it)

Around the time of saccadic eye movements, many oculomotor and visual areas dynamically 'remap' their receptive fields. Remapping across hemispheres has been studied with fMRI by having participants make horizontal saccades so that stimuli switch hemispheres across saccades. Even when the stimulus is extinguished immediately prior to the saccade, increased BOLD has been found in areas ipsilateral to the original stimulus location. However, previous studies have not shown whether this putative correlate of remapping is stimulus- and location-specific or just an unspecific increase in ipsilateral activity such as a change in gain fields or connectivity. We tested spatial specificity by presenting the remapped stimulus either above or below the midline. We looked for spatial selectivity using a GLM conjunction-analysis that identified voxels showing stronger contralateral activation for stimuli presented above versus below midline during trials where no saccade was made AND stronger ipsilateral activation for stimuli presented above versus below midline during trials where a saccade was made. Using this approach, we identified regions in V2/V3 that showed spatially specific remapping. Spatial selectivity was much weaker after remapping, which is incompatible with a pure 'cut & paste' account of achieving visual stability across eye movements.

m Spatiotemporal mechanisms of perisaccadic vision revealed by psychophysical reverse correlation

M Panichi[1,2], M C Morrone[3], D C Burr[1,2], S Baldassi[1] ([1]Dept of Psychology, University of Florence, Italy; [2]Neuroscience Institute, National Council of Research (CNR, Pisa), Italy; [3]Dept of Physiological Sciences, University of Pisa, Italy; e-mail: michelapanichi@gmail.com)

During saccades visual objects become suppressed, mislocalized and compressed in both space and time. We used Psychophysical Reverse Correlation to probe the spatiotemporal characteristics of perisaccadic suppression and compression. In separate experiments, subjects were asked to detect spatial-frequency defined stimuli in 1D noise (space-only) or luminance defined stimuli in 2D noise (space–time), both during fixation and around the time of saccades. We analyzed the relative power spectrum of the templates and computed the first-order (mean) and second-order (variance) kernels for the two types of stimuli. Results show that suppression implies selective inhibition of low-frequency harmonics of the perceptual template. The dynamics of saccadic compression and mislocalization are complex. For preand prismatic targets the template is characterized by early activation preceding the stimulus in both space and time, and by a continuous shift towards later activations, along the spatiotemporal diagonal, for targets presented closer to the saccade landing. We are currently testing several models to account for these e_ects.

m Saliency-guided feature learning in a probabilistic categorization task

N Chenkov[1], J-D Nelson[2,3] ([1]Bernstein Center for Computational Neuroscience, TU Berlin, Germany; [2]Center for Adaptive Behavior and Cognition, Max Planck Institute for Human Development, Germany; [3]Computer Science and Engineering Dept, University of California, San Diego, USA; e-mail: nikolay.chenkov@bccn-berlin.de)

Both salience (eg a high-contrast edge), and task-relevant information (eg a feature that provides information for the viewer's task) help predict visual attention in human saccadic eye movements. How does the visual system balance salience and informativeness? We disentangle these two influences on visual attention via a categorization task with experience-based learning of artificial biological plankton stimuli. The stimuli were designed so that one feature was more salient, but another feature was more useful (leading to 5% higher accuracy). Early in learning, the salient feature quickly attracts attention, as expected. During the learning process, subjects learn to use both features to optimally categorize the stimuli. Remarkably, however, even after learning, subjects view the higher-salience feature first, and perceive it as more useful. One possible explanation is (1) that subjects may use a tree-like classifier, putting the first-learned feature at the top level of the tree, and adding subsequently-learned features only

to lower levels of the tree, even if those features are more informative, and (2) that subjects subsequently presume the top-level feature is most useful, irrespective of the objective usefulness of the features.

m The prominence of behavioural biases in eye guidance

B T Vincent, B W Tatler (School of Psychology, University of Dundee, UK; e-mail: b.t.vincent@dundee.ac.uk)

Research on eye guidance in scene viewing has typically focused upon the contribution of both low-level cues such as edges and contrast, and high-level cues such as object semantics and scene understanding. While advances in computational modelling of eye guidance which incorporates both forms of cue have been made in recent times, we are still a long way from understanding the richness of eye guidance behaviour. Motivated by analysing eye guidance in a probabilistic manner, we show that taking our prior knowledge of behavioural biases into account provides greater insight into the decisions underlying where we look while viewing natural scenes [Tatler and Vincent, 2009 Visual Cognition 17(6/7) 1029-1054]. Out of all possible saccades that could be made, on average we are more likely to

make relatively short saccades in cardinal directions. A model based only on these biases and thus blind to visual information, outperformed salience-based approaches. Our results suggest that incorporating behavioural biases into computational models will significantly improve our understanding of eye guidance in natural scene viewing.

m Crossing the line: eye movements and narrative versus visual continuity in film

B W Tatler[1], Y Hirose[1], A Kennedy[1,2] ([1]School of Psychology, University of Dundee, UK; [2]Laboratoire de Psychologie et Neurosciences Cognitives, Université Paris Descarte, France; e-mail: b.w.tatler@dundee.ac.uk)

The role played by film and video in contemporary society is enormous, as a source of narrative, a means of persuasion, and as simple entertainment. Stimulus changes occur in film (indeed, they are ubiquitous) that could never occur in the real world: an editorial cut can transport the viewer instantaneously to a new location in the scene. We explore the influence of a 180° camera angle change ('crossing the line') in a film of two people in conversation. Crossing the line introduces visual discontinuity: for the film to make sense, the locations of the actors on the screen must reverse. We compare responses to crossing the line when the narrative continuity is preserved (hence with visual discontinuity), and when visual continuity is (artificially) preserved at the expense of narrative continuity by swapping the positions of the actors during the cut. We find eye movements are launched to locations consistent with expectations based on the narrative rather than visual continuity. This result implies that eye movements are driven by an understanding of the expected consequences of filmic conventions, and that these are more powerful factors for inspection behaviour following a cut than the physical content of the scene.

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m Do you look where I look? An investigation of attention shifts and automatic response preparation following dynamic social and non-social cues

F Hermens[1,2], R Walker[1] ([1]Dept of Psychology, Royal Holloway, University of London, UK; [2]Laboratory of Experimental Psychology, University of Leuven (KU Leuven), Belgium; e-mail: hermensf@gmail.com)

Studies of social attention have mostly relied on static images of social cues, such as pictures of faces. Although using static images eliminates confounding e_ects of perceived motion on attention they are unlike the social cues encountered in daily life. Here we compare attention shifts induced by two dynamic cues involved in social attention (eye-gaze shifts and combined eye-and-head gaze shifts) with two movements of others that are not typical of social attention (tilting of the head and walking past without a gaze shift). Three measures of attention shifts and oculomotor preparation were compared: Saccadic response times, saccade errors, and the curvature of saccade trajectories. All three measures show di_erences between the social cues and those not involved in social attention. There are di_erences between the three measures, however, which could indicate that they reveal di_erent aspects of attention shifts and oculomotor preparation when observing dynamic images.

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Talk session: Clinical vision

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m Learning head-centered representations of visual space via topographic maps

T Wachtler, S T Philipp (Dept Biologie II, Ludwig-Maximilians-Universität München, Germany; e-mail: wachtler@biologie.uni-muenchen.de)

During natural viewing, we make several saccadic eye movements per second. However, despite the large shifts of the image of the environment on our retina caused by saccades, we perceive the world as stable: Our visual system achieves a gaze-direction invariant, head-centered representation of visual space. Parietal cortex neurons with so-called gain fields are thought to be involved in the transformation from a retina-centered to a head-centered frame of reference (Zipser and Andersen, 1988 Nature 331 679-684). To investigate how the visual system could achieve such a transformation, we used a biologically plausible network model of spiking neurons that learns invariant features via topographic maps (Michler et al, 2009 Journal of Neurophysiology 102 953-964). When trained with inputs that simulated retinal and gaze-direction signals during visual exploration of visual scenes, the network developed topographic maps that reflected the spatiotemporal statistics of the inputs. Neurons in these maps exhibited gain-field properties similar to those in parietal cortex, and neurons in a subsequent network layer were selective for positions in visual space invariant of gaze direction. Our results show that head-centered representations can be learned in an unsupervised way by exploiting the statistics of visual signals under natural viewing conditions.

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m An integrated model of fixational eye movements and microsaccades

R Engbert[1,2], K Mergenthaler[1,2], A Pikovsky[3,2] ([1]Dept of Psychology, University of Potsdam, Germany; [2]Center for Dynamics of Complex Systems, University of Potsdam, Germany; [3]Physics, University of Potsdam, Germany; e-mail: ralf.engbert@uni-potsdam.de)

When we fixate a stationary target, our eyes generate miniature (or fixational) eye movements involuntarily. Fixational eye movements are classified as slow components (physiological drift, tremor) and microsaccades, which represent rapid, small-amplitude movements. Over recent years, the

investigation of the functional role of fixational eye movements for vision, in particular the function of microsaccades, has been an active research field. Here we propose an integrated mathematical model for the generation of slow fixational eye movements and microsaccades. The model is based on the concept of self-avoiding random walks in a potential and reproduces important statistical properties of the eye's trajectory. Within this framework, we suggest that microsaccades are generated by critical states in an activation field which emerge from the self-avoiding walk. This mechanism generates the experimentally observed reduction of retinal image slip immediately before microsaccades.We conclude that self-avoiding random-walks capture fundamental properties of fixational eye movements.
[This work was funded by Deutsche Forschungsgemeinschaft (DFG), Research Group 868]

TALK SESSION: CLINICAL VISION

m Vision after 53 years of blindness

R Sikl[1], M Simecek[1], O Bezdicek[2], M Porubanova[1] ([1]Institute of Psychology, Academy of Sciences of the Czech Republic, Czech Republic; [2]Dept of Neurology, First Faculty of Medicine, Charles University, Czech Republic; e-mail: sikl@psu.cas.cz)

We report the case of KP, a 71-year-old male who recently received an implant of artificial cornea after becoming blind at the age of 18. Neuropsychological examination of attention, memory, reasoning and executive functions did not reveal any significant cognitive deficit in comparison with normative standards. The results of visual perception experiments were largely predetermined by the subject's impaired ability to segment the visual field. His problems with the parsing of scenes into distinct objects were observed in a set of object recognition, face recognition, and visual space perception tasks. For instance, KP was found to be able to utilize separate depth cues in order to specify spatial relations within the visual scene, but when presented with a complex scene he did not use information from the scene to achieve size constancy. Also, he was found to be less susceptible to context-induced optical illusions (eg Ebbinghaus illusion, Sander illusion, White's illusion). KP's impaired ability to segment the visual field is hypothesized to be accompanied by sequential processing of visual information.
[Supported by GA CR 406-09-2003]

m Visual exploration training and attention training are equally e_ective for treating hemianopia

D T Smith, A R Lane, A Ellison, T Schenk (CNRU, Wolfson Research Institute, Durham University, UK; e-mail: daniel.smith2@durham.ac.uk)

Patients with homonymous visual field defects experience disabling functional impairments as a consequence of their visual loss. compensatory visual exploration training aims to improve the searching skills of these patients in order to help them to cope more e_ectively.However, until now the e_cacy of this training has not been compared to that of a control intervention. Given that exploration training uses the visual search paradigm, which is known to require visual attention, in this study the e_cacy of the technique was compared to a training that requires visual attention but not exploration. Participants completed either exploration training (N=21), or attention training followed by exploration training (N=21). Assessment of the visual field, visual search, reading and activities of daily living were performed before and after each intervention that the participants completed. The results revealed that both the exploration training and the attention training led to significant improvements in most of the visual tasks. For most of the tasks exploration training did not prove superior to attention training, and for reading both types of intervention failed to yield any benefits. The results indicate that attention plays a large role in the rehabilitation of homonymous visual field defects.
[The study was funded by an ESRC / MRC studentship (number PTA-037-2004-00025, AL)]

m Behavioural correlates of impaired object recognition after stroke

C Grimsen[1], I Käthner[1], M Prass[1], F Brunner[2], S A Brandt[3], M Fahle[1] ([1]Dept of Human Neurobiology, University of Bremen, Germany; [2]Stroke Unit, Klinikum Bremen-Mitte, Germany; [3]Vision & Motor Group, Charité Berlin, Germany; e-mail: cgrimsen@uni-bremen.de)

Object identification is mediated mainly by the ventral stream of the human visual system, hence some patients with lesions of object-sensitive cortical areas su_er from object agnosia. This deficit is more severe after bilateral lesions. We tested whether patients with unilateral lesions of the ventral stream without signs of visual agnosia and with intact visual fields su_er from subtle impairments of object recognition. Both, patients and healthy control subjects, had to make a binary rapid categorical decision on images presented either to the ipsilesional or to the contralesional visual field. Subjects solved two categorical tasks: (1) whether or not natural scenes contained an animal and (2) whether a face was male or female. Performance (percent correct) and reaction time were measured. Both patient groups yielded fewer correct and slower responses at the contralesional compared to the ipsilesional presentation side and to controls. Patients with left hemisphere damage were more impaired than patients with right hemisphere damage except for response time in the gender decision task. These results indicate that ventral lesions impair object recognition in stroke patients even in the absence of clinical symptoms of agnosia and suggest some hemispheric asymmetries during object recognition (see also Prass et al, this conference).
[Supported by the German Research Foundation (FA119/17-1)]

m Evidence for a magnocellular loss in extrapyramidal symptom disease

P Bordaberry[1], M Allard[2], S Delord[1] ([1]Laboratoire de Psychologie Cognitive, Université Bordeaux 2 Victor Segalen, France; [2]Laboratoire d'Imagerie Fonctionnelle (UMR 5231), Université Bordeaux 2 Victor Segalen, France; e-mail: pierre.bordaberry@wanadoo.fr)

The objective of this study was to investigate the integrity of both magnocellular and parvocellular pathway in disease with extrapyramidal symptoms. 21 elderly (M=58.7 years; _=6.5) and 24 patients (M=60.2 years; _=9.7) with extrapyramidal symptoms participated. The experiment consisted of two tasks of 120 trials each. Target was displayed for 200 ms above or below a fixation point, in one of its three versions (normal, band-pass, low-pass). The participant then performed either a semantic categorization task (animals/tools) or localization task (up/down). After the experiments, patients received a DaTSCAN (brain scan of the dopaminergic system). Comportemental results revealed significant interaction between type of tasks, type of pictures and population for both correct response rate and response time. Patients showed increasing response time and errors rate in conditions involving magnocellular processing. DaTSCAN analysis demonstrates a correlation between this magnocellular loss and a dopaminergic loss in the striatum (left/right) and in the caudate nucleus (left). These results provide further support for visual processing regard in extra pyramidal disease diagnosis.

Talk session: Clinical vision

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m Brain mechanisms for biological motion processing in children with autism

C M Hudac, K A Pelphrey, M D Kaiser, S M Lee, S Shultz, C Cheung, B Deen, A Berken, D Sugrue, A Voos (Yale Child Study Center, Yale University, USA; e-mail: caitlin.hudac@yale.edu)

Recent work suggests that preferential attention to biological motion, an early-emerging and evolutionarily well-conserved mechanism, is disrupted in autism (Klin et al, 2009 Nature 459 257-261). Dysfunction in the posterior superior temporal sulcus (pSTS), a region implicated in biological motion perception, has been shown in adults with autism [Pelphrey et al, 2005 Brain 128(5) 1038-1048]. Yet, it remains unclear if pSTS abnormalities underlie biological motion perception deficits in autism or result from a lifetime of disrupted preferential attention to biological motion. In this fMRI study, children age 4–17 with an autism spectrum disorder (ASD, N=28) and carefully matched neurotypical controls (N=20) viewed point-light displays of dynamic human biological motion and scrambled version of those same animations with equivalent amounts of motion. Children with an ASD exhibited hypoactivation (biological > scrambled) relative to neurotypical children in the right pSTS, right fusiform gyrus, right ventrolateral and dorsolateral prefrontal cortex, and bilateral amygdalae. Our developmental findings indicate that deficits in these components of the social brain are early-emerging and lifelong features of the brain phenotype in autism.

[Supported by The Simons Foundation, National Institute of Health, and Autism Speaks]

m Altered spatial frequency content in paintings by schizophrenics

D J Graham, M Meng (Dept of Psychological and Brain Sciences, Dartmouth College, USA; e-mail: daniel.j.graham@dartmouth.edu)

While it is di_cult to imagine the way someone with a mental illness perceives the world, paintings produced by mental illness su_erers with artistic talents o_er a hint of this experience. Here we show that spatial frequency content in twelve paintings by five artists with schizophrenia or schizoa_ective disorder is significantly di_erent from that found in a large sample of art by non-schizophrenic painters, while other basic spatial and intensity statistics are not di_erent for the two groups. In particular, amplitude spectrum slopes are significantly steeper for schizophrenics' paintings. We suggest that these results support the notion that schizophrenics show decreased contrast sensitivity at low spatial frequencies: if schizophrenics cannot perceive low frequencies at the same level of contrast as that at which healthy individuals can, it follows that on average they will portray such components with higher contrast—ie schizophrenics will produce images with steeper spectra, or greater relative amplitude at low frequencies. The fact that art in general has a certain typical spectrum is probably due to many factors including luminance compression, approximation of natural scene spatial statistics, materials, and, perhaps, aesthetics. But whatever the contributions of those factors may be, we argue that the same ones should apply for schizophrenic artists.

m Reading and attention disorder and audiovisual discrimination profile

M Ahissar, T Biron (Dept of Psychology and Institute for Neural Computation, Hebrew University, Israel; e-mail: msmerava@gmail.com)

Reading di_culties and attention disorder tend to concur. However, it is still unclear whether functional mechanisms are shared. We now examined auditory and visual frequency discrimination among university students with neither type of di_culty (control), both di_culties (ADHD+RD) and only an attentional di_culty (ADHD). The latter group was defined by accurate reading. This division yielded two ADHD groups with very di_erent auditory profiles and more subtle visual di_erences. Notably, accurate readers (control and ADHD) had similar verbal working memory and similar discrimination thresholds in several 2-tone frequency discrimination tasks. Auditory and verbal memory thresholds were correlated. The ADHD+RD group performed significantly worse in these tasks. Visual impairments were more subtle, and largely similar among both ADHD groups. Yet, the ADHD (only) group was

unique in having low-thresholds when tested with a spatial 2-alternative forced choice task ("which part of the screen, upper/lower, contains higher-frequency gratings?") with no repeated reference stimulus across trials, and high thresholds when tested with a temporal 2-alternative forced choice version of this task. Thresholds in the temporal task were significantly correlated with their reading rate. We propose that the audiovisual discrimination profile provides a good characterization of individuals' reading and attention di_culties.
[Supported by Niederzachsen grant given to Ahissar & Koenig collaboration]

m Quality of eccentric fixation in patients with central scotomas determines performance and brain activation in a visual search task

M W Greenlee[1], F Farzana[1], J Frolo[1], S Brandl-Rühle[2], T Plank[1] ([1]Institute for Experimental Psychology, University of Regensburg, Germany; [2]Augenklinik, University Regensburg, Germany; e-mail: mark.greenlee@psychologie.uni-regensburg.de)

In patients with central scotomas, a large part of visual cortex is not adequately stimulated. Patients often use a new eccentric fixation area on intact peripheral retina ['preferred retinal locus' (PRL)] that functions as a pseudo-fovea. We tested 19 patients with central scotomas (5–20 degrees in diameter) due to retinal dystrophy (Stargardt disease, cone-rod dystrophy) in a visual search task. In this task the letter 'L' had to be detected between several 'T' distractors arranged radially in the peripheral visual field. Additionally, stability of eccentric fixation and saccadic behaviour were determined. Patients with stable fixation had shorter latencies and needed less correction steps in the saccadic task. Further they showed a significantly better performance in the visual search task than patients with unstable fixation. Patients more frequently detected targets when they fell into the area around pseudo-fovea compared to other positions in the visual field. The benefit of a stable pseudo-fovea is also visible in the pattern of fMRI results. When the target stimulus appeared at the position of the pseudo-fovea, we could find significant clusters of higher activation in retinotopic areas of the visual cortex corresponding to the respective PRL. This di_erential brain activation was not observed in healthy controls.
[Supported by DFG Research Group 1075]

TALK SESSION: SPATIAL VISION

m Orientation-dependence of adaptation and masking: isotropic adaptation fails to transfer between the eyes

J R Cass[1,2] ([1]School of Psychology, University of Western Sydney, Australia; [2]MARCS Auditory Research Laboratories, University of Western Sydney, Australia; e-mail: johncassvision@gmail.com)

Much of our understanding about human orientation processing is based on the psychophysical techniques of contrast adaptation and masking. Both methods, however, have yielded highly variable results. We compared the orientation-dependent and independent e_ects of overlay masking and adaptation by measuring changes in detection thresholds as a function of angular di_erence between target and masking/adapting gratings, both monoptically and dichoptically, across a range of spatial frequencies (0.5, 2, and 8 cpd). Both paradigms yielded similar orientation-dependent e_ects under both monoptic and dichoptic conditions: bandwidths were highly stable across spatial frequency (20–30 degrees HWHA), with orientation-tuned amplitudes increasing at higher spatial frequencies. Strong isotropic masking and adaptation were observed only at the lowest spatial frequency, consistent with simultaneous and sequential whitening of the natural amplitude spectrum. Notably, adaptation failed to elicit any untuned e_ect under dichoptic conditions, despite the presence of robust dichoptic isotropic masking at the lowest spatial frequency. These results are consistent with orientation-dependent adaptation and masking being mediated by equivalent cortical mechanisms. The lack of interocular transfer of isotropic adaptation, but not masking, points to a novel functional distinction emerging after binocular integration.
[Supported by a Discovery Project (DP0774697) awarded by the Australian Research Council]

m Combining texture and colour cues in visual segmentation

T P Saarela, M S Landy (Dept of Psychology and Center for Neural Science, New York University, USA; e-mail: saarela@nyu.edu)

Introduction. The visual system can use various cues to segment the visual scene into figure and background. We studied texture and colour segmentation and asked whether these cues are processed by two independent mechanisms or by a single, common mechanism. Methods. Stimuli were 12×12 arrays of 1 cpd Gabor patches. There were two types of patches, arranged in vertical or horizontal, 3-patch-wide stripes. Successive stripes di_ered in patch orientation (texture cue), colour, or both. The patch orientations were symmetrical around 45 degrees (resulting in stripes with 45–# vs 45+# degree patches). Colour variations were isoluminant red–green modulations added to the Gabor-patch luminance modulation (resulting in bright red/dark green vs dark red/bright green stripes). Observers judged stripe orientation. Performance was measured in two single-cue conditions (texture or colour cue alone) and in a combined-cue condition. Results. Performance in the combined-cue condition was better

than in the single-cue conditions. Based on the single-cue (texture or colour) performance, we calculated predictions for the combined-cue condition, assuming independent texture and colour segmentation mechanisms and optimal integration of the cues [ie, $d_{combined} = (d_{texture}^2 + d_{colour}^2)^{1/2}$]. All observers performed at least as well as predicted. Several observers performed significantly better than predicted, suggesting a possible common segmentation mechanism for texture and colour.
[Supported by the Swiss National Science Foundation PBELP1-125415 and NIH EY16165]

m Integrating surface and contour in visual shape detection

J Wagemans, B Machilsen (Laboratory of Experimental Psychology, University of Leuven (KU Leuven), Belgium; e-mail: johan.wagemans@psy.kuleuven.be)

The detection of contours and the segregation of regions enclosed by these contours have mostly been studied in isolation. However, contours and surfaces somehow need to be combined to create a stable perception of shape. Here we use a 2AFC task with arrays of oriented Gabors to determine how observers integrate information from the contour and from the interior surface of a shape embedded in the array. The saliency of the shapes depends on the alignment of Gabors along the shape outline and on the isolinearity of Gabors inside the shape. Shape detectability is measured for the contour cue, for the surface cue, and for the combination of both cues. First, we match performance in the two single-cue conditions. By comparing detectability in the double-cue condition with the two equally detectable single-cue conditions we find a clear double-cue benefit: Participants use both cues to detect the shapes. Next, we compare performance in the double-cue condition with the performance predicted by two models of sensory cue combination: a minimum rule (probability summation) and an integration rule (information summation). Our results indicate that participants apply a combination rule that is better than mere probability summation. We find no evidence against the integration rule.
[Supported by METH/08/02]

m Influences of di_erent grouping principles on response priming e_ects in a primed flanker paradigm

F Schmidt, T Schmidt (Dept of Psychology I, Faculty of Social Sciences, University of Kaiserslautern, Germany; e-mail: filipp.schmidt@sowi.uni-kl.de)

Grouping processes are exceedingly important to organize our environment into coherent units. However, perceptual grouping is no unitary process but a mixture of several coexisting mechanisms (eg grouping by color, continuity) which seem to vary fundamentally in their time course and attentional demands.We performed several experiments to compare the time courses of di_erent grouping principles in response priming e_ects. Primes and targets were arranged in a flanker paradigm, such that two primes were presented side by side at the center of the screen. Targets appeared after a systematically varied stimulusonset asynchrony (SOA) and flanked the primes. Primes and targets were organized by contrasting grouping principles and could trigger the same or conflicting responses. Subjective grouping strength was scaled so that grouping by di_erent principles was comparable in saliency. Response times showed strong priming e_ects which depended on SOA and on whether fast or slow grouping processes served as primes or targets, respectively. We conclude that distinct processes of perceptual grouping are in fact considerably di_erent regarding their time course and influences on the visuomotor system.
[Supported by DFG]

m Crowding is reduced when flankers are suppressed from awareness

T S A Wallis, P J Bex (Schepens Eye Research Institute, Harvard Medical School, USA; e-mail: thomas.wallis@schepens.harvard.edu)

Visual crowding is a failure to discriminate features presented in the peripheral visual field when flanked by similar nearby features. Here we exploit adaptation-induced blindness [Motoyoshi and Hayakawa, 2010 Journal of Vision 10(2):16, 1-8] to suppress flanking elements from awareness in an orientation discrimination task. Under conditions in which flankers were sometimes perceptually suppressed, orientation discrimination thresholds improved relative to conditions in which flankers remained visible. That is, feature discrimination was released from crowding despite flankers being physically present. Moreover, observers showing the greatest release from crowding were those who experienced more flanker disappearances. Since features suppressed by adaptation-induced blindness continue to a_ect visual judgments presumed to depend on cortical area V1 (Motoyoshi and Hayakawa, 2010), our results suggest that crowding depends on interactions with extrastriate visual areas, rather

than lateral connections within V1 alone. We propose this to be an averaging process that operates on the perceived, rather than physical, flanking elements.
[Supported by NIH grants EY018664 and EY019281]

m Feature classification in natural scenes

H Galperin[1], D Lisitsyn[2], P J Bex[2], J Fiser[3,4] ([1]Program in Psychology, Brandeis University, USA; [2]Schepens Eye Research Institute, Harvard Medical School, USA; [3]Dept of Psychology, Brandeis

University, USA; [4]Volen Center for Complex Systems, Brandeis University, USA;
e-mail: hgalp@brandeis.edu)
In a new, generalized classification image framework, we performed a post hoc metaanalysis across seven psychophysical experiments to determine the underlying features utilized during object identification. Stimuli consisted of images of everyday objects constructed from 700 Gabor patches across three spatial frequencies. Signal Gabor elements were assigned positions and orientations defined by the object image, while noise Gabor elements were assigned random positions and orientations. Signal Gabors could be selected independently from image areas composed of smooth edges, corners or randomly. Gabor interelement pairings for all images from 21 000 trials were analyzed. We obtained the distance, element orientation, and contour curvature di_erence between all possible element pairings, yielding element pair distributions for signal and noise elements present on correct or incorrect trials. These distributions were analyzed to determine which element pairings significantly modulated performance. Classification images showed peaks for nearby Gabor pairings whose joint orientations were either similar (smooth contours) or orthogonal (corners and end stopped). These results challenge previous claims that particular orientation structures, such as edges or junctions, are principal features for object recognition, but instead show that the visual system employs a generalized weighted combination of features in object recognition tasks.

TALK SESSION: LEARNING AND MEMORY

m Procedural sequence learning in a motion coherence discrimination task: motor or perceptual?

J Laubrock, A Kinder (Dept of Psychology, University of Potsdam, Germany;
e-mail: laubrock@uni-potsdam.de)
The serial reaction time task (SRTT) is a standard task used to investigate implicit sequence learning. Whereas implicit learning of motor sequences is well-established, few and disputed results support learning of perceptual sequences. Mayr (1996) reported parallel learning of perceptual and motor sequences using manual responses to object identity. However, because objects appeared at widely separated locations, object identification required eye movements—confounding the 'perceptual' location sequence with an oculomotor sequence. Can perceptual sequence learning be established in the absence of eye movements? Here we adapt a motion coherence discrimination task (Newsome and Paré, 1988) to the sequence learning paradigm. The new task has two advantages, (1) the stimulus is presented at fixation, thereby obviating overt eye movements, and (2) by varying coherence, a perceptual threshold measure is available in addition to the performance measure of reaction time. Results from a series of experiments show that motor response relevance of the sequence is necessary for sequence learning to occur, that the amount of sequence knowledge varies with the ease of encoding the motor sequence, and that sequence knowledge, once acquired, has the ability to modify perceptual thresholds.

m Target and mask interaction at di_erent cortical levels in sensory storage

R Bhardwaj[1], J D Mollon[2], H E Smithson[1] ([1]Dept of Psychology, Durham University, UK; [2]Dept of Experimental Psychology, University of Cambridge, UK; e-mail: dr.rishi.bhardwaj@gmail.com)
Sensory storage shows a short-lived part-report advantage that survives an after-coming visual noise pattern [Smithson and Mollon, 2006 QJEP 59(1) 150-160]. We tested whether such superiority survives di_erent types of mask. The target was a 3-by-4 array of digits, and the mask could be (i) a noise pattern, (ii) an array of eights or (iii) an array of random digits. A preliminary experiment ensured that each of the masks was e_ective in rendering the target illegible in an integrated representation: Target and mask were interleaved (at 140 Hz) and target contrast was varied from 0.25–0.64. The target contrast at which performance fell to chance was used in the main experiment, but now target and mask were separated by a blank interval of 100 ms. Auditory part-report cues were presented in precue (729 ms before target onset) and interleaved postcue (21, 143, 264, 386, 507, 629, and 750 ms after target onset) blocks. Whole-report performance was measured in separate blocks. A part-report advantage was found

for all masks in the precue condition, but only for noise masks with postcues. These results suggest that interaction between target and mask in sensory storage depends on the level of cortical processing shared between them.

m Disambiguation of Necker cube rotation by monocular and binocular depth cues: Relative e_ectiveness for establishing long-term bias

S J Harrison, B T Backus (Vision Sciences, SUNY College of Optometry, USA;
e-mail: sharrison@sunyopt.edu)
The perceived direction of rotation of a bistable wire-frame (Necker) cube can be made to depend on retinal location by interleaving the presentation of perceptually ambiguous cubes with cubes that are disambiguated by depth cues. Disparity and an occluder were previously used to disambiguate rotation. Here, we compare the relative e_ectiveness of disparity-plus-occlusion versus a new set of monocularonly depth cues: occlusion, self-occlusion, haze, and a directional lighting source. Rotation was strongly disambiguated by both cue sets. Learned bias persisted, at a reduced level, through a consecutive day of reverse training for both sets. Additionally, each set was equally e_ective at causing reverse learning on Day 2, no matter which set was used on Day 1. Finally, presenting only disambiguated cubes on Day 1

showed that the monocular-only set was more e_ective than disparity-plus-occlusion for training bias, as measured by resistance to reverse learning on Day 2. The e_ectiveness of disparity as a training cue could be mediated by a change in the response of low-level neurons tuned jointly to disparity and motion, but the strong e_ectiveness of the monocular-only set suggests the importance of training higher-level inferential processes that construct the representation of a rotating cube in depth.
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m Consolidation of simple perceptual tasks cannot (always) be disrupted

K C Aberg, M H Herzog (Laboratory of Psychophysics, Brain Mind Institute, École Polytechnique Fédérale de Lausanne (EPFL), Switzerland; e-mail: kristo_er.aberg@epfl.ch)

Freshly acquired memories can be disrupted by a subsequently performed task. For example in motor learning, training a task B disrupts the memory of a previously learned task A, indicating that learning needs consolidation. A study by Seitz et al (2005) reported that perceptual learning also needs consolidation. We failed to reproduce these results, even though we used an almost identical setup and procedure. Participants first trained a session with dot Verniers o_set either to the left or aligned (task A). In a second session, immediately following the first, participants trained with dot Verniers o_set to the right or aligned (task B). Whereas Seitz et al found that the learning of task A was disrupted by training task B, we found that task A was not disrupted by task B. We also failed to find evidence for disrupted consolidation when using bisection stimuli and Verniers. We propose that perceptual learning of simple tasks does not need consolidation.

m Adaptation reveals the mechanisms underlying visual discrimination learning

B S Webb, N W Roach, G S L Coullon (Visual Neuroscience Group, School of Psychology, University of Nottingham, UK; e-mail: bsw@psychology.nottingham.ac.uk)

The brain estimates sensory information by decoding the noisy responses of population of neurons. Mounting evidence suggests that it has developed e_cient and unbiased decoding solutions for most sensory tasks. When making fine discriminations for example, humans optimize their performance by exploiting information-rich signals from neurons tuned away from the discrimination boundary. Yet perturbing the responses of these neurons via short-term adaptation produces substantial costs for discriminative accuracy, suggesting that the brain persists with the same decoding strategy even though it is no longer optimal. We wondered whether the weighting of neural signals for fine discriminations is rigid or can be flexibly reconfigured over longer time scales. Here we show that repeatedly practicing fine direction discrimination whilst in an adapted state dramatically improves the discrimination performance of human subjects to a level that ultimately surpassed that obtained without adaptation. This remarkable improvement came at a price: adapting directions that previously had little e_ect now induced a significant cost for discriminative accuracy. In a detection task, for which di_erent neurons carry most information, we did not find this combination of benefit and cost of learning the same task, suggesting this is not a general phenomenon of learning in an adapted state.
[Supported by Wellcome Trust Research Career Development Fellowship]

Symposium: Visual social perception: brain imaging and sex differences

m Transfer of perceptual learning in a hierarchy of mid-level visual tasks

J W Peirce, D P McGovern, B S Webb (Visual Neuroscience Group, School of Psychology, University of Nottingham, UK; e-mail: jon@peirce.org.uk)

Practice can enhance our ability to perform sensory tasks. Although it was previously thought that this perceptual learning was highly specific for retinal position, stimulus configuration and trained task, recent evidence suggests that, under some circumstances, trained improvements can transfer across the visual field. It is not yet clear if experience-dependent visual improvement can transfer between very di_erent tasks. Here, we trained subjects to discriminate between two arrays of Gabor elements that di_ered in mean orientation, mean curvature or global form. Before and after training on just one of these, participants were tested on all three variants. All groups demonstrated substantial learning on their trained task. Contrary to previous reports they also showed transfer of learning to other tasks that presumably use related mechanisms. For instance, those trained to discriminate orientation, also improved on curvature discrimination, and less so on the global form task. Those trained on global form, also improved on the curvature task, but less so in the orientation domain. The fact that the degree of transfer depended on the relative proximity of the task in the stimulus hierarchy may present a method by which we can study the hierarchy of processing itself.
[Supported by The Wellcome Trust, UK (#WT085444)]

SYMPOSIUM: VISUAL SOCIAL PERCEPTION: BRAIN IMAGING AND SEX DIFFERENCES

m Sex di_erences in body motion perception: combining psychophysics with brain imaging

M Pavlova (Developmental Cognitive & Neuroscience Unit, Children's Hospital, University of Tübingen, Germany; e-mail: marina.pavlova@uni-tuebingen.de)

Perception of dispositions of others is an essential ingredient of adaptive daily-life behaviour. Sex di_erences are evident in the comprehension of social signals, but the underlying basis for these di_erences is unclear. Our findings obtained by combination of visual psychophysics with magnetoencephalophy

(MEG) indicate: (i) gender a_ects accuracy, rather than speed of body language reading. This e_ect is modulated by emotional content of actions; (ii) gender stereotype messages a_ect social perception of events represented as a set of static images. This e_ect is more pronounced in females with a greater force of a negative stereotype message. Gender stereotype looses its power with perception of dynamic displays; (iii) while judging social interaction represented by motion, a robust di_erence in the gamma MEG response occurred between females and males over the left prefrontal cortex, a region implicated in perceptual decision making. The gamma MEG response peaked earlier in females than in males. Taken together, the findings provide novel insights into understanding of the nature of sex di_erences in social perception, and shed light on the interplay between socio-cultural and neurobiological factors. We discuss future directions in uncovering sex di_erences in neuropsychiatric and neurodevelopmental conditions.

m Gender and hormone e_ects on the perception of faces

D I Perrett, B Wi_en, J Lobmaier, J K Lewis, R H Sprengelmeyer, A Hahn, D W Hunter, M R Stirrat, M P Dzhelyova, D Xiao (Perception Laboratory, School of Psychology, University of St Andrews, Scotland, UK; e-mail: dp@st-andrews.ac.uk)

We review the e_ects of reproductive hormones and observer gender on face appearance and perception. Sex di_erences in face structure are apparent from birth: baby boys look older and more independent than baby girls, and masculinity reduces attractiveness in infant faces. Women are more sensitive to infant faces than men. This sensitivity di_erences between genders (a) appears for judgments of infant cuteness, (b) disappears when comparing postmenopausal women with men, (c) is absent for judgments of emotion and age in infant faces, and (d) is modulated by sex hormone levels and experience with infants. Men's growth through puberty exceeds that of women, increasing male facial variation and facial width (relative to face height). Male face width predicts the tendency to exploit others in economic games, and is a cue to perception of low trustworthiness, particularly to women and individuals of low dominance. Trust and attractiveness are further a_ected by head posture. For adult faces, heterosexual women are motivated to work to see attractive faces of either sex, whereas heterosexual men work only for attractive female faces. Sexually dimorphic face traits and attractiveness both a_ect have positive e_ects on motivation to work. Gender di_erences in face perception seem linked to the extent faces activate brain 'reward systems'.

Talk session: Multisensory processing and haptics

Tuesday

65

m Sex di_erences in the visual perception of faces

A M Proverbio[1], E Martin[1], F Riva[1], A Zani[2] ([1]Dept of Psychology, University of Milano-Bicocca, Italy; [2]Institute of Bioimaging and Molecular Physiology, CNR, Milan, Italy; e-mail: mado.proverbio@unimib.it)

Evidence has been provided that infant faces stimulate visual and anterior brain regions belonging to the dopaminergic reward system (left fG, orbito-frontal cortex, nucleus accumbens). The innate preference for baby-schema has been called 'parental response'. In this study, faces of infants, children and adults (randomly mixed with objects and landscapes) were presented to 50 right-handed women and men. Their EEG was recorded from 128 sites. Only in women, P1 response of ERPs was larger to faces than objects. Results showed no sex di_erence in N170 amplitude to objects; a much larger face-specific N170 response over the RH in men, and a bilateral N170 response in women. LORETA reconstruction showed a significant left and right asymmetry in the activation of the FG, in women and men, respectively. In both sexes, N170 response was larger to infant than adult faces, and to faces vs objects. Orbito-frontal N2 was greater to infants than children in women, and to children of whatever age than adults in men. LORETA identified the intracranial generator of N2 'parental response' in the left FG, uncus, cingulate and orbito-frontal cortex. The results are discussed in the view of ethologic models on sex di_erences in social cognition.

m Sex di_erences in the development of brain mechanisms for social perception

K A Pelphrey (Yale Child Study Center and Dept of Psychology, Yale University, USA; e-mail: kevin.pelphrey@yale.edu)

I will discuss developmental functional magnetic resonance imaging (fMRI) experiments from my laboratory that have begun to chart the development of the neural circuitry involved in various aspects of social perception in typically developing children and adolescents from ages 4–17 years of age. Our results reveal distinct developmental trajectories of brain mechanisms supporting di_erent components of social perception including analyzing the intentions and motivations of others (the amygdala, ventrallateral prefrontal cortex, and the posterior superior temporal sulcus), sharing attention and intentions (medial prefrontal cortex and the intraparietal sulcus), and representing another person's perceptions and beliefs (temporal-parietal junction and the precuneus). Notably, we observe sex di_erences in the timing and rates of development in these circuits. We hypothesize that interactions among these dissociable mechanisms appear to support the emergence of ontogenetically and phylogenetically more complex aspects of social cognition. Sex di_erences in the development of the individual circuits and their interconnections could represent a brain mechanism for well-documented sex di_erences in social perception and social cognition abilities.

m Nonconscious vision and new explorations of residual visual abilities for face and body

perception following V1 lesions
B de Gelder[1,2] ([1]Cognitive and A_ective Neuroscience Laboratory, Tilburg University, Netherlands; [2]Martinos Center for Biomedical Imaging, Massachusetts General Hospital, USA; e-mail: B.deGelder@uvt.nl)
In this talk we present new findings of nonconscious perceptiom of faces and bodies in normals and residual visual abilities in hemianopes. There is evidence for a crucial role of the collicular-extrastriate pathway in nonconscious visuo-motor integration, by showing that in the absence of V1 the superior colliculus (SC) is essential to translate visual signals that cannot be consciously perceived into motor outputs. We found that an achromatic (gray) stimulus presented in the blind field of a patient with unilateral V1 loss, although not consciously seen, can influence his behavioral and pupillary responses to consciously perceived stimuli in the intact field (implicit bilateral summation). Notably, this e_ect was accompanied by selective activations in the SC and in occipito-temporal extrastriate areas. A second set of studies investigated processing of a_ective stimuli. Facial responses were recorded using electromyography and physiological arousal was measured with pupil dilatation. All stimuli triggered emotional reactions that were congruent with the a_ective valence displayed, irrespectively of whether the stimulus was a face or a body. We conclude discussing DTI analysis of possible pathways sustaining residual vision.

TALK SESSION: MULTISENSORY PROCESSING AND HAPTICS

m Time channels: Adaptation of auditory and visual duration

C Aaen-Stockdale, J Hotchkiss, J Heron, D Whitaker (Bradford School of Optometry and Vision Science, University of Bradford, UK; e-mail: c.aaen-stockdale@bradford.ac.uk)
Previous studies have suggested that our perception of duration, or temporal extent, may be dependent upon our recent sensory history. In the current study we adapted observers to either visual or auditory stimuli of a fixed duration, and then used a crossmodal duration discrimination task to investigate whether their subsequent perception of time was biased. We measured the perceived duration of visual and auditory stimuli centred on 320 ms after repeated exposure to adaptation intervals of between 40 and 2520 ms, and also without adaptation. Results showed that adaptation to fixed durations produced a marked symmetrical contraction or expansion of perceived duration, within the same modality. The amplitude of this e_ect ranged from 4–15% of the standard duration, and the e_ects were limited to a bandwidth of approximately 1.1 octaves (audition) and 1.5 octaves (vision). Our results provide compelling evidence for visual and auditory timing mechanisms that are markedly influenced by recent sensory history, show a high degree of independence from one another and are adaptable within a limited 'channel'.
[Supported by The Wellcome Trust, UK]

m Multiple, concurrent, temporal recalibrations for audiovisual speech

W Roseboom, D H Arnold (School of Psychology, University of Queensland, Australia; e-mail: roseboom@psy.uq.edu.au)
The point of perceptual synchrony for audio (AUD) and visual (VIS) events can be shifted by exposure to asynchronous AV relationships. Given that we can be exposed to multiple multisensory events simultaneously, and that these may exhibit di_erent timing relationships due to intensity fluctuations and variable viewing distances, a general recalibration of AV synchrony may not be beneficial. Here we investigated whether it is possible to induce and maintain multiple concurrent temporal recalibrations for AV speech. Using clips of male and female actors, we introduced a 300 ms AUD lag to one clip and a 300 ms AUD lead to the other. Following an adaptation period, with repeated presentations of these asynchronous clips in di_erent locations, we found that AV speech synchrony estimates were shifted toward the timing of the corresponding (male or female) adaptor— two concurrent, and opposite, temporal recalibrations. We found that these concurrent AV speech synchrony recalibrations were primarily identity based. There was only a weak modulation when we switched test locations relative to adaptor locations. Our results show that multiple concurrent estimates of AV synchrony can be maintained, and that these estimates are constrained by contextual information, in this case the identity of the speaker.

m Seeing ahead: adaptation to delays in visual feedback recalibrates v**isu**omotor simultaneity perception

M Rohde, L C J van Dam, M O Ernst (Multisensory Perception and Action Group, Max Planck Institute for Biological Cybernetics, Germany; e-mail: marieke.rohde@tuebingen.mpg.de)
The human capacity to adjust perceptually and behaviourally to spatial perturbations (eg, prism goggles) has fascinated researchers for a long time. To study whether such perceptual adaptation through sensorimotor skill learning also occurs in the temporal domain, we trained 10 participants on a visuomotor control task with feedback delays. Before and after adaptation, simultaneity perception was tested in a separate visuomotor temporal order judgments task (subject motion before or after visual stimulus?). Participants steered a moving dot through a maze with a stylus/graphics tablet for ca. 30 minutes with a 200 ms visual feedback delay. Over training, the point of subjective simultaneity (PSS) shifted 45±7 ms towards perceiving the visual stimulus first. No PSS shift occurred in the no delay

control group (two-sample t-test: $p<0.001$). A negative aftere_ect in task performance (drop from 0.86 to 0.32) was found in the experimental but not in the control group (sign test: $p=0.002$), whose magnitude tends to correlate with the PSS shift. We conclude that adaptation to feedback delays in a specific visuomotor control task leads to more general recalibration of perceived visuomotor simultaneity, a result with potential relevance for human computer interaction in the presence of transmission delays.
[The authors would like to thank the HFSP for supporting this research]

m How important is 3D information for haptic object recognition?

R Lawson (School of Psychology, University of Liverpool, UK; e-mail: rlawson@liv.ac.uk)

Raised, 2D line drawings of familiar objects are extremely di_cult to identify using active touch. In contrast, haptically explored, real, 3D objects are usually recognised e_ciently (though slower and less accurately than visually presented objects). Real, 3D objects have more depth information than 2D line drawings, but also extra cues to identity (eg, size, texture, compliance). No studies have directly compared 2D to 3D haptic object recognition whilst controlling for other information sources, so the importance of depth for haptic identification has not been assessed. In the present experiments, people named plastic, small-scale models of familiar objects. Five versions of 18 bilaterally symmetrical objects were produced. Versions varied only on the amount of depth information: minimal for raised line drawings and filled-in drawings, partial for squashed objects and half objects split along the plane of symmetry, and accurate for 3D models. Recognition was faster and much more accurate when more depth information was available, whether exploration used both hands or just one finger. Surprisingly, plane misorientation did not impair performance. In contrast to vision, for haptics 3D information seems more important than object orientation for object recognition, independent of other cues to identity and exploration time and exploration mode.
[Supported by a Fellowship from the Economic and Social Research Council (RES-000-27-0162)]

m Hitting a target is really di_erent from avoiding obstacles

M P Aivar[1], E Brenner[2], J B J Smeets[2] ([1]Faculty of Psychology, Universidad Autónoma de Madrid, Spain; [2]Human Movement Sciences, Vrije Universiteit Amsterdam, The Netherlands; e-mail: mariapilar.aivar@uam.es)

To successfully move around, it is important to consider not only the target of our movements but also any other objects in the environment that may act as obstacles. Nevertheless, it seems that targets and obstacles are treated di_erently when controlling hand movements: in a previous set of experiments we found that the time needed to respond to a change in position was considerably longer for a displacement of an obstacle than for a displacement of the target (Aivar et al, 2008 Experimental Brain Research 190 251-264). However that e_ect could also be explained in other ways, since in that study the obstacles di_ered from the target in several respects. In the present study we compared participants' performance in two tasks that were precisely matched in terms of movement requirements: to hit two identical targets sequentially or to hit the second target through a gap that corresponded precisely with the first target. We found that subjects responded much faster to the displacement of the first object when it was a target than when it was a gap between two obstacles. This shows that obstacles are even treated di_erently than targets when the kinematic requirements they pose are identical.
[Supported by grant FFI2009-13416-C02-02]

m Hand movement investigations inspired by Yarbus

A M L Kappers, F T Douw (Physics of Man, Helmholtz Institute, Utrecht University, The Netherlands; e-mail: a.m.l.kappers@uu.nl)

Inspired by the work of Yarbus [1967 Eye movements and vision (Plenum Press, New York)] on eye movements, we investigated the dependence of hand movements on 'scene' and question about the scene. Our scenes consisted of arrays of 3×3 samples of materials (each sample 10×10 cm), that could di_er in material properties, such as roughness or heat conductance, or in orientation of texture. Questions we asked our participants were, for example, "Which of the 9 samples feels coldest?"; "Describe the relief"; "Which sample is the roughest?". We used an Optotrack system to track the position of the index finger of the dominant hand. Our results show that di_erent materials and di_erent questions lead to very distinctive movement patterns, whereas di_erent participants produce remarkably similar movement patterns. We were able to classify the patterns by using algorithms that detected 'roundness', 'straightness' and 'static touch'. Future investigations should lead to a more comprehensive classification.
[Supported by EU-project "THE Hand Embodied" (#248587)]

m Noise vs sensory integration: The return of the race model

T U Otto, P Mamassian (Laboratoire Psychologie de la Perception, Université Paris Descartes, France; e-mail: thomas.otto@parisdescartes.fr)

The combination of information from multiple sensory signals usually improves perception. For example, reaction times to two redundant signals (like an auditory and a visual stimulus) are typically faster than reaction times to either of the single signals. In analogy to a higher probability for a 'small number' when playing with two dices and not only one, a speeding-up is expected from a 'race' between two parallel

processes. This is also known as probability summation. Interestingly, following the interpretation provided by the influential 'race-model-test' (Miller, 1982 Cognitive Psychology 14 247-279), fastest reaction times typically exceed probability summation. Consequently, it is argued that only genuine (multi-)sensory integration can account for the observed speeding-up. Here, we reevaluate the racemodel-test and question its casual use because the test heavily relies on the untested assumption that processing is not changed whether one or two signals are processed. Then, based on entire reaction time distributions measured with single and redundant signals, we show that what is regularly interpreted as an integration gain can in fact reflect—as an instance of deteriorated processing—an increased noise level in the central nervous system. Consequently, we argue that several prominent demonstrations of (multi-)sensory integration need to be revisited because race models have been wrongly rejected.
[TUO was supported by the EU project CODDE and the Swiss National Science Foundation]

RANK LECTURE

m The Rank Lecture: Has imaging told us anything new about human visual organisation?

R Frackowiak (Service de Neurologie, Centre Hospitalier Universitaire Vaudois Lausanne (CHUV), Switzerland; e-mail: richard.frackowiak@gmail.com)

The functional architecture of the occipital cortex is being studied with increasing detail. Functional and structural MR based imaging are altering views about the organisation of the human visual system. Recent advances have ranged from comparative studies with non-human primates to predictive scanning. The latter multivariate technique describes with sub-voxel resolution patterns of activity that are characteristic of specific visual experiences. One can deduce what a subject experienced visually from the pattern of cortical activity recorded. The challenge for the future is to understand visual functions in terms of cerebral computations at a mesoscopic level of description and to relate this information to electrophysiology. The principal medical application of this new knowledge has focused to a large extent on plasticity and the capacity for functional reorganisation. Crossmodality visualsensory interactions and cross-correlations between visual and other cerebral areas in the resting state are areas of considerable current interest. The lecture will review findings over the last two decades and reflect on possible roles for imaging studies in the future.

POSTER SESSION: 3D VISION, DEPTH I

m1

Infants' perception of depth from a pictorial cue: Comparing monocular and binocular preferential-looking

A Tsuruhara[1], S Corrow[2], S Kanazawa[3], M K Yamaguchi[4,5], A Yonas[2] ([1]Research and Development Initiative, Chuo University, Japan; [2]Institute of Child Development, University of Minnesota, USA; [3]Faculty of Integrated Arts and Social Sciences, Japan Women's University, USA; [4]Dept of Psychology, Chuo University, Japan; [5]PRESTO, Japan Science and Technology Agency, Japan; e-mail: aki.tsuruhara@gmail.com)

We describe a new method for assessing depth perception in infants who are too immature to use preferential reaching to the closer of two objects to measure space perception. We tested the hypothesis that young infants will look longer at an object that appears closer to them by comparing monocular and binocular preferential looking to objects in which depth was specified by the height-in-the-picture plane cue. Infants were presented with two figures that varied in their vertical position on a computer monitor. When viewed with one eye, the pictorial cue indicates that the lower object is closer than the higher one; when the same display is viewed with two eyes, binocular information specifies that the objects are actually equidistant. Because the displays are identical in the monocular and binocular conditions, except for disparity and vergence cues, the di_erence in looking-behavior between the two conditions indicates sensitivity to depth information. Our study found that four-month-old infants looked at the lower, and apparently closer, figure significantly longer in the monocular condition than in the binocular condition. This suggests that di_erences in monocular and binocular preferential looking provide a useful measure of pictorial depth sensitivity in four-month-old infants.
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m2

Do Vernier acuity thresholds depend on perceived or actual retinal eccentricity?

B Erten[1,2], H Boyaci[1,2] ([1]Dept of Psychology, Bilkent University, Turkey; [2]National Research Center for Magnetic Resonance (UMRAM), Bilkent University, Turkey;
e-mail: bgm.erten@gmail.com)

Vernier acuity (VA) thresholds increase with retinal eccentricity, and correlate with cortical magnification in human V1 (Duncan and Boynton, 2003 Neuron 38 659-671). On the other hand, 3D context can dramatically a_ect the perceived retinal eccentricity of an object, and the spatial distribution of neural activity in human V1 correlates better with the perceived retinal eccentricity (Fang et al, 2008 Current Biology 18 1707-1712). Motivated by these results, we investigated whether VA thresholds depend on the actual or perceived retinal eccentricity. Using a 2IFC adaptive procedure we measured the VA thresholds by manipulating the perceived eccentricity while keeping the actual eccentricity constant.

We placed a rectangular object either at a 'near' or 'far' position in computer-rendered 3D scenes rich with depth cues. We then superimposed the Vernier stimuli to the left or right of a central fixation mark painted on the object. When the stimuli were presented at the far position, they appeared to be at a larger eccentricity compared to when they were presented at the near position, even though the actual eccentricity was always the same. We found no e_ect of the manipulation on the VA thresholds, suggesting that VA depends on actual but not perceived retinal eccentricity.
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m3

Temporal property of depth reversal

S Sunaga[1], M Sato[2] ([1]Dept of Human Science, Kyushu University, Japan; [2]Dept of Information and Media Engineering, University of Kitakyushu, Japan; e-mail: sunaga@design.kyushu-u.ac.jp)

The phenomenon that perceived depth is opposite to depth predicted from binocular disparity is known as depth reversal. We measured apparent depth as a function of stimulus duration at di_erent binocular disparities in order to investigate the temporal property of depth reversal. Binocular disparity introduced into a random-dot stereogram was modulated sinusoidally along a horizontal axis to produce a vertical corrugation in depth. The spatial frequency of disparity modulation was 0.4 cpd. The peak or trough was at the center of the pattern. The amplitude of disparity modulation was either 0.17, 0.25, 0.33, or 0.5 deg. The duration was varied from 33 ms to 17 s at the interval of 1 octave. The observer's task was to respond the direction of the apparent depth of the center of the pattern. Depth reversal was remarkably observed in the condition of 500 ms duration at the large binocular disparity for three observers. As the duration became longer, apparent depth became consistent with depth predicted from binocular disparity. These results suggest that the mechanism concerned with depth reversal works prior to the depth mechanism based on the binocular disparity when the disparity is relatively large.

m4

Interactions between shading and disparity for depth perception

J M Harris[1], M Bloj[2], P G Lovell[1] ([1]School of Psychology, University of St Andrews, UK; [2]School of Optometry and Vision Sciences, University of Bradford, UK; e-mail: p.g.lovell@st-andrews.ac.uk)

A classic way to study di_erent aspects of perception is to consider how information from di_erent cues is combined to generate a percept. Artists and others use luminance gradients (shading) to provide a sense of depth and shape in images. Here we report on studies examining factors that influence the combination of depth cues defined by monocular shading and the well studied depth cue of binocular disparity. Ray-traced images (RADIANCE) were created either featuring a smooth surface illuminated from above (shading-channel), or a surface defined by small spheres (disparity-channel). The shadingand disparity-defined pairs were combined by placing dots in the stimulus image, superimposed upon the shaded surface, at the locations of the spheres, resulting in veridical shading and binocular disparity. By independently varying the depth delivered by these channels, we created stimuli with conflicting depth-defined and shading-defined information. We find that when disparity and shape information are combined for depth perception, disparity information does not dominate perception. Under some circumstances, PSEs for depth judgments reflect values that lie between the two conflicting cues. The combination of depth cues is influenced by the extent of the overall discrepancy, larger conflicts appear to force the identification of dual-layers rather than a combined surface.
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m5

Eye movements during mental rotation of 2D and full-3D objects of varying types and degrees of complexity

P Francuz (Dept of Experimental Psychology, John Paul II Catholic University of Lublin, Poland; e-mail: francuz@kul.pl)

The goal of the present research was to verify the hypothesis concerning di_erences between eye movement trajectories registered during mental rotations of objects presented in 2D vs full-3D (stereoscopically). The objects also di_er on account of two independent variables: (1) the type of complexity, measured by the number of (a) separated pieces constituting each object or (b) points and angles which define its shapes and (2) the complexity level (greater or fewer parts or points and angles which constitute given objects). On the one hand, it was found that stereoscopically presented objects were mentally rotated more quickly and correctly than analogous objects previously viewed on the flat computer screen. However, there were no di_erences between more or less complex objects of any type in accord with the RT's and the correctness of mental rotation. On the other hand, the amplitudes of eye movements were higher for 2D than for full-3D presented objects, but the average time of fixation points was similar in these two situations. The scanned areas of interest were smaller for objects which were composed of separated pieces than for one-piece objects. The results are discussed in the context of the complexity hypothesis.
[Supported by the Polish Ministry of Science and Higher Education Research Grant (No. N106 064135)]

m6

Aging and divided attention in 3D space
M Grosjean, G Rinkenauer (IfADo Leibniz Research Centre, Technical University Dortmund, Germany; e-mail: grosjean@ifado.de)
It has recently been shown that older, like younger, adults are able to divide their attention between nonspatial stimulus attributes: Responses to redundant targets (eg, with the proper shape and color) are faster than responses to single targets (eg, with only the proper shape or color). For both age groups, these redundancy gains were best accounted for with a coactivation model rather than a separate-activations (race) model of parallel information processing. The purpose of the present study was to explore whether and how older individuals can divide their attention between spatial (depth) and nonspatial (color) stimulus attributes. In a redundant-target detection paradigm, younger (mean age=23.7 years) and older (mean age=73.0 years) participants were asked to respond to the appearance of a stereoscopically presented stimulus that either had the proper color and/or (virtual) depth. Redundancy gains were obtained in both age groups, however only the younger adults showed evidence of coactivation. This points to a potential qualitative change in the parallel processing of 3D (stereoscopic) information with age.

m7

Objective measurements of fixation disparity, controlled by variation of vergence stimulus
W Jaschinski, W B Kloke (IfADo Leibniz Research Centre, Technical University Dortmund, Germany; e-mail: jaschinski@ifado.de)
Fixation disparity, i. e. the vergence error for stationary fusion stimuli, is clinically relevant and can have implications for stereoscopic depth perception. Since fixation disparity typically subtends much less than 1 deg, it is di_cult to be measured objectively with eye trackers. We propose a measurement procedure that inherently includes a control of the precision of the actual individual measurement. We used the EyeLink II in 12 subjects, each with 12 repeated tests: for a stationary fusion stimulus at 60 cm viewing distance, the stimulus disparity was varied by small amounts in the uncrossed and crossed direction (−20, −10, 0, 10, 20 arcmin). The median slope of the resulting vergence function was 0.8 with a median 95% confidence interval of ±0.2. The intercept of the vergence function represents the fixation disparity, which had a median individual confidence interval of ±3 arcmin (upper quartile ±4 arcmin). Fixation disparity ranged from −30 (exo) to 15 (eso) arcmin; the standard deviation of fixation disparity across subjects was 8 arcmin, while it was 5 arcmin within the average subject. This procedure provides reliable individual measures of fixation disparity, as confirmed by the precision of the actual test.

m8

The spatial range of local depth contrast e_ect
H Shigemasu[1], M Yoshida[2] ([1]School of Information, Kochi University of Technology, Japan; [2]Dept of Knowledge-based Information Engineering, Toyohashi University of Technology, Japan; e-mail: shigemasu.hiroaki@kochi-tech.ac.jp)
We previously reported (Shigemasu and Kitazaki, 2008 Perception 37 ECVP Supplement, 57) that a convex surface placed next to planar surfaces with uncrossed disparity (ie placed behind) had a flatter

appearance. We suggested that this e_ect is caused by local depth contrast of surfaces. In this study, we investigated the spatial range of this local e_ect. To estimate the range of the e_ect, we put other planar surfaces with crossed disparity (ie placed in front) outside of the surfaces which were adjacent to the convex surface. The width of inner surface was manipulated from 3.2 to 38.6 min. If the disparity signals of two planer surfaces are spatially pooled, the local depth contrast e_ect should be smaller when the inner planar surfaces become narrower. The results showed that the flattening e_ect becomes smaller when the width became narrower and the curved surface appeared more convex when the width was narrowest (3.2 min), while inner surfaces alone having the same width showed flattening e_ect. The results also showed that the e_ect of the width did not change when the width was more than 25 min. These results suggest that disparity signals of surfaces are spatially pooled and the range of the local e_ect is up to 25 min.

m9

Interaction of monocular and binocular vision
C J Erkelens (Physics of Man, Helmholtz Institute, Utrecht University, The Netherlands; e-mail: c.j.erkelens@uu.nl)
Monocular vision uses assumptions known as the Gestalt laws of perceptual organization. Additional assumptions about the eye's point of view and about the layout of the 2D image lead to 3D perception that is surprisingly often veridical. Binocular vision is based on epipolar geometry. In the absence of monocularly recognizable patterns, the binocular visual system exploits the epipolar geometry for the unambiguous reconstruction of the 3D scene. In conclusion, there is room for 3D interpretation and ambiguity in monocular vision, whereas in binocular vision there is not. Therefore, one would expect binocular vision to be superior to monocular vision in inducing a veridical 3D percept. The opposite seems to be the case. For instance, monocular vision dominates binocular vision in experiencing depth from 2D pictures. Another example is seeing depth reversals in ambiguous 2D pictures. I investigated interaction of monocular and binocular vision by measuring distributions of depth reversals during

viewing of monocularly visible and hidden Necker cubes. Reversals occurred in all conditions, although less frequently in fully camouflaged Necker cubes. This result suggests that monocular and binocular vision use common neural representations of shapes and objects in the brain. I speculate that binocular vision did not develop as a separate visual system but as an add-on to monocular vision.

m

10

Evidence for conjunction coding of motion and disparity in human visual cortex

K J Seymour, C W G Cli_ord (Dept of Psychology, Sydney University, Australia; e-mail: kiley_seymour@yahoo.com.au)

Psychophysics suggests that motion and binocular disparity interact early in visual processing. Single unit recordings in the monkey also provide evidence for the joint encoding of these features across most of the dorsal visual stream. Here we used fMRI and multivariate pattern analysis to examine where in the human brain conjunctions of disparity and motion are encoded. Subjects sequentially viewed two stimuli that could be distinguished only by their conjunctions of motion and disparity. Specifically, each stimulus contained the same feature information (clockwise and counterclockwise motion, and crossed and uncrossed disparity) but di_ered exclusively in the way these features were paired. Our results revealed that a linear classifier could accurately decode which stimulus a subject was viewing based on voxel activation patterns distributed throughout the dorsal visual stream, as early as V1. This decoding success was conditional on some voxels being individually sensitive to the unique conjunctions comprising each stimulus, thus a classifier could not rely on independent feature information to distinguish these conjunctions. This study expands on evidence that disparity and motion interact at many levels of human visual processing, particularly within the dorsal stream. It also disentangles conjunction coding from simply joint selectivity of these features.

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m

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Enhancement of perception of depth in hologram reconstructions by motion and stereo

R Näsänen[1], T Colomb[2], Y Emery[2], T Naughton[1,3] ([1]RFMedia Lab Oulu Southern Institute, University of Oulu, Finland; [2]Lyncee Tec Inc. Lausanne, Switzerland; [3]Dept of Computer Science, National University of Ireland, Ireland; e-mail: risto.nasanen@oulu.fi)

We investigated the question of how the perception of depth in hologram reconstructions on conventional displays depends on motion and binocular disparity. Perceived depth was estimated by using an adjustable random pattern stereogram. Using the stereogram the observer could produce perceived stereoscopic depth of di_erent amounts behind and in front of the display surface corresponding to the perceived depth in certain points in hologram reconstructions. The objects in holograms were

a microscopic biological cell and a macroscopic coil. Additionally, the e_ect of spatial frequency content of hologram reconstructions on perceived depth was studied by using low-pass and bandpass filtered images. Stereoscopic presentation increased perceived depth substantially in comparison to non-stereoscopic presentation. When stereoscopic cues were weak or absent, motion increased perceived depth considerably. However, when stereoscopic cues were strong, the e_ect of motion was small. Depth perception was reduced at low spatial frequencies. Thus, blur in images reduced depth cues. The same was true for very high spatial frequencies for which the visibility was low. These e_ects were less prominent in the presence of motion. In conclusion, for the maximisation of perceived 3D information it seems highly beneficial to use the combination of motion and stereoscopic presentation.

m

12

Experimental and numerical study of chromostereopsis: Depth inversion e_ects due to the background color

T Hayashi[1], H Takeoka[2], R Tanaka[1] ([1]Faculty of Informatics, Kansai University, Japan; [2]OGIS-RI, OGIS Research Institute Co., Ltd., Japan; e-mail: hayashi@res.kutc.kansai-u.ac.jp)

Chromostereopsis is a visual perception where a specific color is perceived nearer or farther than other colors in the plane pattern which consists of more than 2 colors. The mechanism is considered to be binocular stereopsis by the chromatic aberration of the eyeball optical subsystem, but quantitative evaluation has not previously been satisfactory. In the present study, a reversal phenomenon of the depth by background color and a change in the magnitude of depth were studied both experimentally and numerically. A stereo pair of red and blue stimulus patterns (random dots) on a black or white background was used in the experiment. Subjects matched the binocular disparity by a keyboard operation so that the depth of the red and blue pattern might become the same. As a result, the equivalent disparity was 0.9–1.9 arcmin on a black background and (–0.5)–(–1.1) arcmin on a white background. Numerical simulation based on ray-tracing using the LeGrand's model eye showed good agreement with the experimental results. By using the simulation, we show that various visual phenomena in chromostereopsis can be explained quantitatively.

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Apparent shape distortion induced by binocular disparity depends on disparity distribution pattern
Y Tamada, M Sato (Graduate School of Environmental Engineering, University of Kitakyusyu, Japan; e-mail: d09f0201@hibikino.ne.jp)
The direction of depth specified by disparity is sometimes perceived opposite to that of the geometrical prediction, referred as depth reversal. Previous studies suggested that depth reversal occurs because apparent shape distortion induced by disparity serves as a perspective cue to depth opposite to that by disparity and more weight is assigned to perspective than to disparity. Our previous study showed that depth reversal occurred frequently in a slanted flat surface but not in a curved surface simulated by disparity. This suggested that apparent shape distortion and/or weighting to depth cues depend on disparity distribution pattern. Present study tested this expectation. The stimulus was a grid pattern subtended 20 deg with depth modulation of disparity and/or perspective in presenting a slanted or curved surface. Apparent depth and shape was quantified by a matching method. Five out of sixteen subjects perceived the reversed depth only in the flat surface. These five subjects gave greater weight to perspective than to disparity, but their weighting did not di_er among the disparity patterns. The greater shape distortion was perceived in the flat surface than that in the curved one. We concluded that the shape distortion, not weighting, depends on the disparity distribution pattern.
m
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Underestimation of the perceived number of depth layer defined by discrete motion parallax
T Kayahara (School of project design, Miyagi University, Japan; e-mail: kayahara@myu.ac.jp)
Motion parallax is one of the important monocular cues for visual depth perception. In our previous study (Kayahara, 2008 Perception 37 ECVP Supplement, 142), perceived number of the depth-layer defined by the discrete velocity-di_erence of small square patches (like random-dot pattern) was examined to evaluate whether the perceived number of the depth-layer is in proportion to the physical number of that, varying the number of square patches in one layer. The results revealed that the perceived number was not in proportion to the physical number, and was saturated at a small number, suggesting that our visual system might comprehend 3D space with small number of categorical depth layers (like 'near, middle, far'). In the previous study, however, the density of the content (distance between square patches) in one depth layer was not equalized between the conditions. Thus, in this study, the perceived

number of depth-layer as a function of the physical number of that defined by motion parallax with equalized density of the content was evaluated psychophysically, and saturation of the perceived number of depth-layer as a function of the physical number of that and its dependence on the number of content was observed again.
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m
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A binocular vision model considering vergence eye movements for solving autostereograms
T Kohama, Y Hirata (Faculty of Biology-Oriented Science and Technology, Kinki University, Japan; e-mail: kohama@info.waka.kindai.ac.jp)
This study proposes a binocular vision model that reconstructs 3D structures from autostereograms, single-image stereograms that connote disparity information into a single image. The previous binocular vision models involved inputting two images for the right and left eyes, and cannot detect depth information from the autostereograms. Our model is a modified version of the stereo model by Hayashi et al and serves to introduce fusion processes by vergence eye movements in order to obtain depth information from autostereograms (Hayashi et al, 2004 Vision Res 44 2367-2380). Since autostereograms have a periodic plane as the background, our model starts with the vergence motion of two windows corresponding to the left and right eyes to search maximal output of the binocular energy unit that produces autocorrelation-like patterns of the background. Once the optimum vergence angle has been determined, the model calculates paired or unpaired points using the same procedure employed in the model by Hayashi et al. The results indicate that the model can reconstruct 3D structures even from autostereograms, suggesting that the disparity detection system coordinates with the eye movement system to accurately derive depth perception.
m
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Depth percept from horizontal and vertical motion parallax by to-and-fro head motion
M Fujita[1], M Ishii[1], M Satou[2] ([1]Media Engineering Course, University of Toyama, Japan; [2]Digital Signal Processing Course, University of Kitakyushu, Japan;
e-mail: m0971128@ems.u-toyama.ac.jp)
Depth perception from motion parallax is evoked by not only right-and-left motion of the observer

but also to-and-fro motion. Motion parallax di_ers between right-and-left and to-and-fro motion: a horizontal translation of the head produces horizontal image deformation on the retina, on the other hand a to-and-fro translation causes both horizontal and vertical deformation. In this study, we investigated depth percept from horizontal and vertical motion parallax by to-and-fro head motion. Stimulus was a set of five white-colored dots aligned vertically or horizontally in a darkroom and presented on a computer monitor. Three dots (the center and the both ends) and the other two dots were simulated to appear with di_erent depth. The dots were moved in synchronization with the observer's head. Fixation point was given at the center of the stimulus or at a separated place of it.Observers were asked to observe stimulus monocularly with head motion and to decide if the three dots were farther or closer than the other two dots. Results indicate that vertical motion parallax is e_ective in perceiving depth for the horizontally aligned dots, and horizontal motion parallax for the vertically aligned dots .

m

17

Apparent depth of picture in mirror

A Higashiyama[1], K Shimono[2] ([1]Dept of Psychology, Ritsumeikan University, Japan; [2]Dept of Logistics and Information Engineering, Tokyo University of Marine Science and Technology, Japan; e-mail: achan@lt.ritsumei.ac.jp)

We investigated the hypothesis that absolute distance of a target in mirror is ambiguous because of two conflicting cues regarding absolute distance of the target—(i) the distance of the mirror itself and (ii) the distance of the virtual target. Thus, the visual system may rely on cues to relative distance (ie pictorial cues) in mirror perception. To examine this hypothesis, in Experiment 1, 22 participants freely and binocularly viewed 11 naturalistic pictures and their mirror-reflected pictures. Specifically, each participant held a hand-mirror to which a picture was reflected and judged which of the real or the virtual picture appeared larger in depth. In Experiment 2, another 22 participants made free and monocular observation of the same real and virtual pictures. In Experiment 3, still another 22 participants made monocular observations of the same pictures with the limitation that the pictures were in the same frontoparallel plane. There was no significant di_erence among the results of the three experiments, and about 73% of the participants reported that virtual pictures appear larger in depth compared with the real pictures. These results support the hypothesis mentioned above.

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Tuesday

Poster session: Adaptation, aftereffects

m

18

Infants' sensitivity to pictorial depth cues in looking studies: A meta-analysis

C E Granrud[1], A Yonas[2], M Kavšek[3] ([1]School of Psychological Sciences, University of Northern Colorado, USA; [2]Institute of Child Development, University of Minnesota, USA; [3]Institute for Psychology, University of Bonn, Germany; e-mail: carl.granrud@unco.edu)

Studies of infant looking behavior toward pictorial depth cues have reported inconsistent findings on whether the ability to extract pictorial depth is present at 3 to 4 months of age or whether it develops later in the first year of life. We therefore conducted a meta-analysis of the existing habituation-dishabituation and preferential-looking studies. Our results suggest that the ability to respond to pictorial depth cues emerges in a stepwise manner. In step 1, from 3 to 5 months of age, infants can perceive the di_erence between displays in which pictorial depth cues specify a variation in depth and displays that do not specify depth di_erences, and they direct their attention preferentially to displays specifying variations in depth. In step 2, from about 6 months of age on, infants extract 3D shape and other spatial characteristics from pictorial depth cues. However, consistent with recent preferential-reaching studies, perception of distance from pictorial depth cues can be shown in 4- to 5-month-old infants when multiple cues are presented under monocular viewing conditions, which strengthen the impression of three-dimensionality.

m

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Is the Moon Illusion a celestial ames demonstration?

K Brecher (Dept of Astronomy and Physics, Boston University, USA; e-mail: brecher@bu.edu)

To most naked eye observers, the Moon appears 30 – 50% larger when seen near the horizon than it does when seen near the zenith. The 'Moon Illusion' has been reported from as early as the fourth century BC and has been the subject of hundreds of papers and two books. Its explanation does not lie in the realm of physics (atmospheric refraction) or astronomy (eccentric lunar orbit) but, rather, in the realm of visual perception. As part of 'Project LITE: Light Inquiry Through Experiments', we have been developing inexpensive experiments and demonstrations that can be easily constructed. including a miniature Ames Room. Our 'digital' Ames Room has been designed to be printed using an inkjet printer from a PDF file posted on the Project LITE web site http://lite.bu.edu and then cut and folded to make the room. When viewed through one wall using a commonly available door viewer, it dramatically demonstrates how the visual system assesses the relative size of objects when making comparisons with the surrounding environment in which the objects are placed. In this presentation we will discuss some insights that the Ames Room provides that may o_er clues to a quantitative explanation for the Moon Illusion.

[Project LITE is supported by the NSF through DUE Grant # 0715975]

m

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The role of high-level visual areas in short- and long-lasting forms of neural plasticity

M Maniglia, A Pavan, G Campana, C Casco (Dept of General Psychology, University of Padua, Italy; e-mail: marcello.maniglia@gmail.com)

Striate and extrastriate neurons present short-term synaptic depression and facilitation in response to brief stimulations. Recent studies have shed light on some possible relationships between these shortterm forms of neural plasticity and patterns of psychophysical behavior. It has been shown that a brief adaptation to directional motion biases the perceived direction of a subsequently presented ambiguous test pattern towards the same direction to that of the adaptation [rapid visual motion priming (rVMP)], but only after brief adaptation-test blank intervals. Increasing the adaptation duration, the perceived motion direction of the ambiguous test pattern is biased towards the opposite direction [rapid motion aftere_ect (rMAE)]. In our study we used contracting and expanding circular gratings to selectively elicit activity at the level in which neurons respond to optic flow components (ie, MT and MST neurons). We attempted to assess whether the rapid e_ects exist and, if so, their timescale. Results revealed strong rMAEs, a long lasting facilitation that arises gradually with intermediate and long blank intervals (perceptual sensitization), but we did not observe rVMP. We interpreted results on the basis of competition between coexistent forms of short- and long-term synaptic depression and facilitation implemented at di_erent visual cortical circuitries.

m

21

Global-shape aftere_ects: evidence for a local substrate

D R Badcock[1], J E Dickinson[1], R A Almeida[1], J Bell[1,2] ([1]Human Vision Laboratory, School of Psychology, University of Western Australia, Australia; [2]McGill Vision Research, Dept of Ophthalmology, McGill University, Canada; e-mail: david@psy.uwa.edu.au)

Adaptation to stimuli is a ubiquitous property of the visual system that optimises its dynamic range. It is common to consider the e_ects of adaptation in the context of the inducing stimuli, eg orientation

di_erence between successively-presented lines is exaggerated and an object's shape appears di_erent after viewing a similar shape; enhancing shape contrast. Orientation and shape adaptation are often thought to arise at di_erent levels of analysis. Here we consider whether adaptation within a substrate of local oriented line detectors results in enhanced shape contrast for similar shapes. Using psychophysical techniques we show object specific adaptation of a spatially coincident circle and Cartesian grid. We show that the tilt aftere_ect predicts local changes in perceived orientation, and that smoothly varying fields of such local e_ects can account for the global change in perceived shape. We then show this process generalises to account for shape adaptation in faces. A shape aftere_ect will occur in any pattern with modestly di_erent local orientations to the adaptor.

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m

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Intermanual transfer of eye-muscle potentiation distance aftere_ect

A-E Priot[1,2], B Priot[3], R Laboissière[1], C Roumes[2], C Prablanc[1] ([1]UMR-S 864 'Space and Action", INSERM, France; [2]Département ACSO, Institut de Recherche Biomédicale des Armées (IRBA), France; [3]DEOS, ISAE, Université de Toulouse, France; e-mail: aepriot@imassa.fr)

Aftere_ects in distance perception following exposure to base-out prisms without hand visual feedback may be explained as a result of eye-muscle potentiation (EMP). We tested the following predictions about EMP: (i) Equal EMP-related aftere_ects should be observed on both exposed and unexposed hands; (ii) EMP-related aftere_ects for both hands should be correlated with changes in tonic vergence assessed by changes in far phoria. During the 10-min exposure, the fourteen right-handed subjects had to point to a visual target located within reaching space with their left unseen hand while wearing 5_ base-out prisms. Pre- and post-exposure tests consisted of far phoria measurements (Maddox rod) and egocentric distance estimation by open-loop pointing to visual targets with left and right hands. Despite interindividual variability, a complete intermanual transfer of distance aftere_ect was obtained: (left) exposed and (right) unexposed hands exhibited no significant di_erence in aftere_ects mean or variance. Aftere_ects on both hands were significantly correlated with changes in far phoria (R=0.7 for left hand and R=0.65 for right hand). The results indicate that, as an axial component of adaptation based on oculomotor adjustments, EMP fully transfers to unexposed e_ectors.

m

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E_ect of prism adaptation on non-visual straight ahead pointing task in dyslexic children

A Brenk-Krakowska[1], P Ja´skowski[2] ([1]Laboratory of Vision Science and Optometry, Faculty of Physics, Adam Mickiewicz University, Poznan, Poland; [2]Dept of Cognitive Psychology, University of Finance and Management Waszawa, Poland; e-mail: alicja@optyka.com.pl)

Unilateral neglect is a disorder involving di_culty in attending to the side of space contralateral to brain injury. It is known that prism adaptation ameliorate some neglect symptoms. Moreover it has been recently demonstrated that the developmental dyslexics show an asymmetry of attentional distribution between left and right visual field, which resembles mild symptoms of left unilateral neglect. Here we investigated performance of dyslexic children in the non-visual straight ahead pointing (N-SAP) before and after rightward prism adaptation. In the main experiment, healthy and dyslexic children performed visuo-motor tasks contain pointing to the left or right target while wearing 15° prismatic goggles. We found that dyslexics showed left non-visual 'minineglect' while normal readers showed 'pseudoneglect' (overestimation of the left visual field) in N-SAP before adaptation. Surprisingly, dyslexics adapted faster to prism and their aftere_ects were higher than those in control group, a result being in conflict with a recent study (Brooks et al, 2007) which was claimed to provide a strong evidence for impaired cerebellar function. Conversely, leftward bias in N-SAP and pathological high aftere_ect resemble those observed in left neglect. Taking together our results suggested deficits in visual attention in dyslexics, probably involving impairment of the right posterior parietal cortex.

m

24

A fMRI study of a face after e_ect

L Zhao (Brain and Cognitive Sciences Institute, Henan University of Science and Technology, China; e-mail: bcshaust@163.com)

After long adaptation to a distorted face, the perception of observer to face is distorted. Here we applied fMRI to investigated the neural mechanism of this face after e_ect. We used 2 event-related experiments to measure the observer response in fusiform face area. In the first experiment, after adapting to normal face for 5 minutes, 5 distorted face and the normal face were presented randomly and counterbalanced for 10 times. In the second experiment, the adaptation were changed to a distorted face, everything else were the same. To keep the observer alert and excluding the attention e_ect, the observers were asked to respond to a short-time presented dim red cross. The EPI BOLD sequences were collected by a Picker

1.5T Eclipse MRI machine. The data were processed using SPM5 and MarsBar4.1. We did not find any consistent pattern in the data. There is no consistent BOLD signal decrease or increase in fusiform face area. One possible explanation of the result is that the face after e_ect is not like the more easily observed object after e_ect which only need short time adaptation and is processed in early object/face stream. Face aftere_ect may be processed in more further module in the object/face stream.

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Size adaptation: E_ects on perception and action

E Zimmermann[1,2], R Arrighi[1], A Pooresmaeili[3], M C Morrone[2], D C Burr[1,4] ([1]Psychology Dept, University of Florence, Italy; [2]Dept of Physiological Sciences, University of Pisa, Italy; [3]Vision Laboratory, Scientific Institute Stella Maris, Italy; [4]Neuroscience Institute, National Research Council, Italy; e-mail: eckart@in.cnr.it)

All primary sensory attributes are adaptable. Maintained prolonged exposure to a specific stimulus property induces perceptual adaptation aftere_ects, usually in the opposite direction to the adaptor. We applied this technique to investigate adaptation of stimulus size and found strong visual aftere_ects. Adaptation to stationary stimuli of 10 deg diameter caused smaller stimuli (5 deg) to be perceived as smaller (about 30%) and larger stimuli (12 deg) to be perceived as larger (about 15%). The illusion also a_ected spatial position information: Visual space perception was measured by judging the apparent spatial location of briefly flashed bars. Stimuli flashed near to the adapted location were perceived shifted in the direction of the size aftere_ect, while stimuli flashed in the center of the adapted location were perceived veridically. To test whether adaptation a_ected actions as well as perception we asked subjects to saccade to the border of an object. For reactive saccades, amplitudes were decreased as if the saccade had been executed to a larger object. Express saccades, however, tended to be veridical, thus showing that they were triggered by a signal representing the physical not the illusory target position .

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On the role of visual adaptations on aesthetic appreciation via changes of the object space

S J Faerber[1,2], C-C Carbon[1] ([1]Dept of Psychology, University of Bamberg, Germany; [2]Insitute of Psychological Basic Research, University of Vienna, Austria; e-mail: stella.faerber@univie.ac.at)

Objects can be determined by their typicality, which is highly correlated with their aesthetic appreciation. We investigated how visual adaptation to untypical objects changes their typicality and aesthetic appreciation. To be able to vary variables important for aesthetic appreciation in an independent way, we decided not to use given natural material but experimentally manipulated material from the stimulus class 'chairs' based on 3D-CAD models. We systematically varied the two orthogonal dimensions form (via inflation) and arousal level (saturation) on ten levels each to implement an object space and investigated

changes in this object space due to its typicality und its aesthetic appreciation. In a test–retest paradigm we found out di_erences in the di_erentiation in the implemented dimensions for typicality and aesthetic appreciation and changes on the dimension inflation turned out to be stronger for typicality than for aesthetic appreciation. Importantly, we showed that changes in object space took place in a systematic way, leading to a translation of the object space towards the used adaptation stimuli. This helps to understand complex and dynamic changes of aesthetic appreciation over time and elaboration.

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Detection of a novel aftere_ect: Angle adaptation

S Talehy-Moineddin[1], E Rahmani[1], Y Najian Tabriz[2] ([1]Medical Students' Research Committee (MSRC), Iran University of Medical Sciences (IUMS), Iran; [2]Sharif Entrepreneurs and Researchers Institute (SERI), Baqiyatallah University of Medical Sciences, Iran; e-mail: sh.talehy@gmail.com)

Introduction: Adaptation or aftere_ect is widely used to study the human visual cortex. Low level aftere_ects (eg, color and orientation) are broadly studied as well as high level aftere_ects (eg, face and biological movement); while intermediate level adaptation (eg, angle and curvature) has been neglected. The reason of this gap seems to be the overlap between low and intermediate level aftere_ects. In this study, we examined whether adaptation to angle size is detectable while adaptation to line orientation is excluded. Methods: Subjects (3 females and 2 males) were first trained to discriminate between angles larger and smaller than 45 degrees with an accuracy level of at least 90%. Then they participated in three experiments. In the first and second experiments they were adapted to 35° and 55° angles respectively, and there was no adaptation phase in the third experiment. In the first two experiments, test stimuli were rotated so that orientation adaptation could not interfere with angle size aftere_ects. Results: Logistic regression analysis showed a statistically significant di_erence between the results of the three

experiments ($p<0.001$). Discussion: To the best of our knowledge, this the first time that adaptation to angle size is detected.

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The influence of surround suppression on adaptation in primary visual cortex

A Kohn, S Wissig (Dept of Neuroscience, Albert Einstein College of Medicine, USA; e-mail: adam.kohn@einstein.yu.edu)

Adaptation—the prolonged presentation of stimuli—has been used extensively to probe mechanisms of visual processing in perceptual, physiological, and imaging studies. Neurophysiological studies have focused on how adaptation a_ects single neurons, typically using stimuli tailored to evoke robust responses. Linking perceptual, neural and imaging e_ects, however, requires understanding the e_ects on neural populations with adapters that may provide weak or even suppressive drive to many cells. To directly address how neural populations adapt to a visual input, we implanted microelectrode arrays in primary visual cortex of macaque monkeys and measured responses to di_erent visual stimuli before and after adaptation. We find that adaptation can produce a much broader range of e_ects in V1 than previously considered, including response facilitation and shifts in preference toward the adapter. A critical factor determining how neurons adapt is the relative drive provided to the receptive field center and surround. Our data reveal a much richer repertoire of adaptation e_ects than previously considered and suggest an intimate relationship between spatial and temporal contextual e_ects.

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m

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Binocular integration in human vision adapts to maximize information coding e_ciency

K A May[1], L Zhaoping[1], P B Hibbard[2] ([1]Dept of Computer Science, University College London, UK; [2]School of Psychology, University of St Andrews, UK; e-mail: keith@keithmay.org)

The two eyes typically receive correlated inputs, from which one can derive two decorrelated channels: binocular summation (S_+) and binocular di_erence (S_-). The channel gains (g_+, g_-) should adapt to optimize the tradeo_ between information transmission and energy usage, giving an inverted-U function of signal strength: strong signals are suppressed to conserve energy with little information loss, and weak signals are suppressed to avoid wasting energy transmitting noise (Li and Atick, 1994 Network 5 157-174). The relative strengths of the S_+ and S_- signals depend on the interocular correlation. We adapted observers to positive correlations (both eyes saw identical natural images, giving stronger S_+ than S_-), zero correlations (each eye saw a completely di_erent natural image, giving equal-strength S_+ and S_-) or negative correlations (each eye saw the photonegative of the other eye's image, giving weaker S_+ than S_-). We assessed the gain ratio g_+/g_- from cyclopean motion direction judgments for a dichoptic display in which the S_+ signal contained motion in the opposite direction to the S_- and monocular signals. For high adaptation contrast, g_+/g_- was lower after adapting to positive than zero or negative interocular correlations; the opposite occurred for low adaptation contrast. The data are explained by an inverted-U gain function.

[Supported by Gatsby Charitable Foundation and Cognitive Science Foresight Grant BBSRC #GR/E002536/01]

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Visual aftere_ects for walking reveal underlying neural mechanisms for action recognition

N E Barraclough, T Jellema (Dept of Psychology, University of Hull, UK; e-mail: n.barraclough@hull.ac.uk)

We present results illustrating a new high-level visual aftere_ect: observing actors walking forward, without horizontal translation, make subsequent actors appear to walk backward, while the opposite e_ect is obtained after observing backward walking. We used this aftere_ect, which cannot be explained by simple low-level adaptation to motion direction, to investigate the properties of neural mechanisms underlying recognition of walking actions. Our results suggest that the perception of walking actions containing movement and the perception of static images of actors in walking postures relies on common brain mechanisms that are primarily object-centered, rather than viewer-centered, and are 'blind' to the identity of the actor. These results obtained with human psychophysical adaptation techniques support previous evidence accumulated using single unit recording in nonhuman primates, and should be incorporated into current models of human action recognition. We conclude that action-adaptation is a powerful technique to determine the brain mechanisms in humans that underlie our perception of the behavior of other individuals.

[British Academy]

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Visual awareness of objects, their colour and orientation

M Pilling, A Gellatly (Dept of Psychology, Oxford Brookes University, UK; e-mail: mpilling@brookes.ac.uk)

An abrupt cueing task (eg Wolfe et al, 2005 Visual Cognition 14 749-780) was given to measure visual awareness of objects and their associated features. Displays consisted of variable numbers of coloured (red or blue) and tilted (±45°) bars given at pseudorandom screen locations. When cued, observers were required to make forced-choice reports about the presence of a specified object at that location (ie did it contain a red bar, a right-tilted bar?). Analysis compared false-alarm rates in reporting a specified object at two locations: distractor locations and empty locations. For colour, a similar false alarm rate was found in reporting a specified object at both types of location; when reporting orientation a far higher level of false alarms was found at distractor object locations compared to empty locations. This pattern of results suggests that the conscious representations we form of the objects in our field of vision always encode surface colour but not necessarily their other highly discriminable features. Results are interpreted in terms of the Boolian map framework of attention (Huang and Pashler, 2007 Psychological Review 114 599-631).

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Eye movements during multiple object tracking: The role of 'rescue saccades'

G J Zelinsky[1,2], A Todor[2] ([1]Dept of Psychology, Stony Brook University, USA; [2]Dept of Computer Science, Stony Brook University, USA; e-mail: Gregory.Zelinsky@stonybrook.edu)

Observers tracked 2–4 sharks (9 total) as they swam throughout an underwater scene. Consistent with Zelinsky and Neider (2008), tracking accuracy was >95% with 2–3 targets, but dropped to 74% with 4 targets. Interestingly, the proportion of time spent looking at targets increased with tracking load. What function do these saccades serve during tracking? To determine whether this load-related looking bias might be attributed to target occlusion, we analyzed the proportion of target occlusions that were accompanied by a shift in gaze to the target. We refer to these as 'rescue saccades'; eye movements to targets in danger of being lost due to occlusion. Rescue saccades accompanied 50% of the Track 2–3 target occlusions, but only 34% of the Track 4 occlusions. Their frequency also decreased with increasing distance between a target and the nearest other object, suggesting that it is the potential for target confusion that summons a rescue saccade, not occlusion itself. These findings provide evidence for a tracking system that monitors for events that might cause track loss (eg occlusions), and requests help from the oculomotor system to resolve these momentary crises. As the number of crises increase with the number of targets, some requests for help go unsatisfied, resulting in degraded tracking.

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m

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Feature-specific facilitation following a spatial cue

K E Burnett, A C Close, G d'Avossa, A Sapir (School of Psychology, Bangor University, UK; e-mail: psp813@bangor.ac.uk)

A dual-task experiment was designed to determine whether a spatial cue that is predictive for one feature

impacts detection of a second feature. A random-dot kinematogram (RDK) was presented in each quadrant of the screen. Participants were asked to report the direction of translating dots that appeared in one RDK, and the location or absence of a colour probe. The probe was a brief colour change of one RDK dot, occurring in 50% of the trials. A single endogenous precue predicted the location of the coherent motion with 70% validity, but was uninformative for the probe location. We expected that once attention was directed to one location by the cue, accuracy at the cued location would be higher than at uncued locations in both tasks. However, a validity e_ect was found in motion discrimination but not probe detection accuracy. In a second experiment, the endogenous cue was 70% valid for the probe location and uninformative for coherent motion. There was no validity e_ect for motion discrimination, but a validity e_ect was evident for probe accuracy. It is concluded that attention may be selectively oriented to features based on spatial cue validity.
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Fatigue of visual attention: E_ects of time-on-task on sensory and capacity limits of attention
A Csatho[1], D van der Linden[2], I Hernadi[3], P Buzas[4], G Kalmar[1] ([1]Institute of Behavioral Sciences, University of Pecs, Hungary; [2]Institute of Psychology, Erasmus University Rotterdam, The Netherlands; [3]Institute of Biology, University of Pecs, Hungary; [4]Institute of Physiology, University of Pecs, Hungary; e-mail: arpad.csatho@aok.pte.hu)
A common experience with mental fatigue is the di_culty in sustaining attention focused on a task when potentially interfering distractors are present. These fatigue-related impairments might be the consequences of at least 3 di_erent mechanisms: (1) decreased perceptual ability, (2) decreased capacity of attention to the target or (3) a di_culty to inhibit distraction. We contrasted these explanations by testing how mental fatigue a_ects the sensory and capacity limits of attention. Participants (N=20) performed a visual attention task (a flanker task) for 2.5 hours without rest. Stimuli were presented that consisted of target letters at di_erent perceptual load and a peripheral distractor letter. Three targetdistractor conditions were tested: neutral, congruent, and incongruent. Sensory saliency (luminance contrast) of the target letter varied across trials. Performance measures, EEG, as well as subjective fatigue ratings were recorded. Reaction times, fatigue ratings and EEG band powers increased with time-on-task (TOT). With increasing TOT, the distractor e_ect became stronger for trials with less salient targets. In contrast, TOT showed no clear e_ect on attentional capacity. Results indicate that decreased performance in a prolonged attention task is mediated by sensory limits while the attentional capacity seems to be unchanged.
[Supported by Bolyai Research Fellowship and OTKA (PD79147)]
m
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Spatial probability in hemispatial neglect
A Shaqiri[1,2], B Anderson[1,3] ([1]Dept of Psychology, University of Waterloo, Canada; [2]Dept of Psychology, University of Lausanne, Switzerland; [3]Centre for Theoretical Neuroscience, University of Waterloo, Canada; e-mail: albulena.shaqiri@unil.ch)
Our research investigated whether probability cuing could improve visual task performance in participants su_ering from hemispatial neglect. Previous studies (Druker & Anderson, in submission; Geng & Behrmann Neuropsychologia 44 1050-1060) have shown that probability can act as a cue and improve RT of healthy participants and participants su_ering from neglect in simple visual detection or discrimination tasks. We asked participants to judge the color of a stimulus appearing on a computer screen over 4 sessions of 200 trials each. We varied the screen locations where stimuli were likely to appear. Our results for the group of healthy participants (N=5) and the group of participants who have had a brain stroke (N=4) showed an improvement in RT and accuracy over sessions for the high probability region. Neglect participants (N=2) and participants who previously su_ered from neglect (N=2) did not improve their performance to stimuli appearing in the high probability region. These results suggest a di_culty for participants with lesions in the right parietal lobe to update information from the contralesional side of space. Further research should elucidate this updating process in order to e_ectively address rehabilitation of neglect.
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Atypical local perception precedence in preschooler poor readers
S Franceschini[1], N Corradi[1], M Ru_no[2], S Gori[1], T Gianesini[1], A Facoetti[1,2] ([1]Dipartimento di Psicologia Generale, Centro di Scienze Cognitive, Università di Padova, Italy; [2]Unità di Neuropsicologia dello Sviluppo, Istituto Scientifico ‘E Medea’ Bosisio Parini, Italy; e-mail: sandrofranceschini@gmail.com)
Impaired phonological processing is widely assumed to be a main cause of developmental dyslexia (DD). However, also visual magnocellular-dorsal (M-D) deficits are frequently shown in children with DD. In a longitudinal study, we measured, in preschooler children, the interference of global stimuli on

the processing of local stimuli as well as the interference of local stimuli on the processing of global stimuli by using a variant of Navon task. After one year, we tested the reading abilities in the same sample. Preschooler good readers presented the typical global interference e_ect during local processing, whereas poor readers did not showed this e_ect, suggesting a global perception deficit. In contrast, poor readers showed a larger local interference e_ect during global processing in comparison to good readers. This results demonstrate that children that will present reading di_culties, had a pre-existent atypical local perception precedence, suggesting that visual M-D stream e_ciency could play a specific role before reading acquisition.

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Poster session: Attention I

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Subitizing but not estimation of numerosity requires attentional resources

G Anobile[1,2], M Turi[1,2], D C Burr[1,2] ([1]Dept of Psychology, Università degli Studi di Firenze, Italy; [2]CNR Neuroscience Institute, Università degli Studi di Firenze, Italy; e-mail: giovannianobile@hotmail.it)

The numerosity of small numbers of objects, up to about four, can be rapidly appraised without error, a phenomenon known as subitizing. Larger numbers can either be counted, accurately but slowly, or estimated, rapidly but with errors. There has been some debate as to whether subitizing uses the same or di_erent mechanisms than those of higher numerical ranges, and whether it requires attentional resources. We measured subjects accuracy and precision in making rapid judgments of numerosity for target numbers spanning the subitizing and estimation range while manipulating the attentional load, both with a spatial dual-task and the 'attentional blink' dual task paradigm. The results of both attentional manipulations were similar. In the high-load attentional condition, Weber fractions were similar in the subitizing (2–4) and estimation (5–7) range, (10–15%). In the low load and single task condition, Weber fractions substantially improved in the subitizing range, becoming nearly error-free, while the estimation range was relatively una_ected. The results show that the mechanisms operating over the subitizing and estimation ranges are not identical. We suggest that preattentive estimation mechanisms works at all ranges, but in the subitizing range attentive mechanisms also come into play.

[Space, time and number in the brain (STANIB)]

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Developmental dyslexia: Perceptual noise exclusion deficit or spatial attention dysfunction?

M Ru_no[1], S Gori[2], S Franceschini[2], A Facoetti[1,2] ([1]Unità di Neuropsicologia dello Sviluppo, La Nostra Famiglia - IRCCS 'E.Medea", Italy; [2]Dipartimento di Psicologia Generale, Centro di Scienze Cognitive, Università di Padova, Italy; e-mail: ru_nomilena@gmail.com)

Developmental dyslexia (DD) is characterized by a multi-sensory perceptual noise exclusion deficit. Indeed, dyslexics typically show a specific deficit in the ability to detect relevant stimuli (the signal) when spatiotemporal irrelevant stimuli (the noise) are closely presented. However, spatial attention seems to be the crucial process involved in perceptual noise exclusion and it has shown consistently impaired in dyslexics. The aim of the present study was to verify whether a defective automatic shifting of visual attention could explain the perceptual noise exclusion deficit in children with DD. Accuracy in identifying a target was measured in 31 dyslexics and 23 normally reading children by an experimental paradigm including two attentional (focused vs unfocused) and two noise conditions (signal vs signal plus lateral noise). Our results confirm, in children with DD, a specific target identification deficit when stimuli were displayed with lateral noise. More importantly, dyslexics were specifically impaired in the signal plus lateral noise only in focused attention, suggesting that the attentional shifting process could a_ect the general perceptual noise exclusion mechanism in DD.

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Visual attention 'spills' from targets to distractors under low perceptual load: An oculomotor investigation of the perceptual load model

H L Pincham, D Szucs (Centre for Neuroscience in Education, University of Cambridge, UK; e-mail: hlp31@cam.ac.uk)

The perceptual load model of selective attention proposes that late-selection occurs in low perceptual load environments where spare attentional resources 'spill' over to process distractor stimuli (Lavie and Tsal, 1994 Perception and Psychophysics 56 183-197). Conversely, under high load, capacity limitations mean that distractors are only processed to an early, perceptual level. Despite the model's potential value in applied distraction research, previous investigations have employed artificial viewing conditions that prohibit naturalistic eye-movements. Given the link between fixation position and attention, we hypothesised that attentional 'spilling' should be apparent in participants' oculomotor responses. Eyemovements were therefore recorded whilst participants detected pre-defined targets in visual-search arrays. Reaction times, initial saccade latencies and number of fixations all increased with load. Although distractors interfered with target detection speed, this interference was not confined to low load trials (as predicted by the model), but persisted across loads. Importantly, however, a larger proportion of

low load trials contained distractor fixations than did high load trials. That is, distractors were more likely to be fixated when perceptual load was reduced. This study is the first to reveal that attention —as assessed through fixation position—literally spills from targets to distractors when perceptual resources are not taxed.
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The role of attention in a masked-prime e_ect
G G Cole[1], G Kuhn[2] ([1]Centre for Brain Science, University of Essex, UK; [2]Dept of Psychology, Brunel University, UK; e-mail: ggcole@essex.ac.uk)
'Primes' are known to exert an influence on the time taken to process a subsequent target. One example is seen in the 'negative compatibility e_ect'. Response times to determine the left-right orientation of an arrow (ie the target) are relatively slow if a prime is also an arrow whose direction corresponds with that of the target. When the direction of the arrow is opposite to the prime response times are relatively fast. Various explanations have been posited including accounts based on masking and inhibitory processes. In four experiments we examined whether a shift of spatial attention contributes to the phenomenon. Results showed that the prime typically presented in the negative compatibility e_ect shifts attention from the location of the subsequent target. Consequently, response times to process an arrow target are shorter if the arrow's direction is compatible with the last shift of attention. In other words, the prime, via its influence on spatial attention, a_ects the representation of left and right which in turn a_ects the speed with which the direction of an arrow can be discriminated. We argue that the influence of attention on the negative compatibility e_ect occurs due to shared representations of perception and action.
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Targets benefit from temporal preparation! Evidence from para- and metacontrast masking
B Rolke, V C Seibold (Dept of Psychology, University of Tübingen, Germany; e-mail: bettina.rolke@uni-tuebingen.de)
When participants can anticipate the temporal occurrence of a target stimulus, perceptual processing of the target is facilitated. In three masking experiments, we investigated the characteristics of this perceptual processing benefit by temporal preparation. In Experiment 1, we replicated the perceptual processing benefit observed in earlier studies by employing a metacontrast paradigm in which the stimulus onset asynchrony (SOA) between the target and the following mask was varied. In Experiment 2, we addressed the question whether the perceptual benefit is limited to the first of two stimuli. To do so, we employed a paracontrast paradigm in which the mask precedes the target by the SOA. Finally, in Experiment 3, we excluded strategic e_ects, ie the knowledge whether the first or the second of two stimuli constitutes the target. Therefore, we combined both metacontrast and paracontrast paradigms within one experiment. In all three experiments, discrimination performance for targets was enhanced by temporal preparation. The results show that not only the first of two stimuli benefits from temporal preparation but that temporal preparation improves target specific or location specific processing.
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m
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Rule-based modulation of visual attention allocation
S Taya[1], D Windridge[2], J Kittler[2], M Osman[1,3] ([1]Dept of Psychology, University of Surrey, UK; [2]Centre for Vision Speech and Signal Processing, University of Surrey, UK; [3]School of Biological and Chemical Science, Queen Mary Collage, University of London, UK; e-mail: s.taya@surrey.ac.uk)
In what way is information processing influenced by the rules underlying a dynamic scene? In two studies we consider this question by examining the relationship between attention allocation in a dynamic visual scene (ie a singles tennis match) and the absence/presence of rule application (ie point allocation task). During training participants observed short clips of a tennis match, and for each they indicated the order of the items (eg players, ball, court lines, umpire, and crowd) from most to least attended. Participants performed a similar task in the test phase, but were also presented with a specific goal which was to indicate which of the two players won the point. In the second experiment, the e_ects of goal-directed vs non-goal directed observation were compared based on behavioural measures (self-reported ranks and point allocation) and eye-tracking data. Critical di_erences were revealed between observers regarding their attention allocation for items related to the specific goal (eg court lines). Overall, by varying the levels of goal specificity, observers showed di_erent sensitivity to rule-based items in a dynamic visual scene according to the allocation of attention.
[Supported by EPSRC (EP/F069626/1)]
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Development of component functions of selective attention in children

S Utz, J Krummenacher (Dept of Psychology, University of Fribourg, Switzerland;
e-mail: Sandra.Utz@unifr.ch)
Bundesen (1990 Psychological Review 97 523-547) assumes in his Theory of Visual Attention (TVA) that visual selective attention is reflected in independent component processes: visual short-term memory

(vSTM) capacity, processing speed, top-down control of resource allocation to relevant information, and spatial distribution of attentional weight in the visual field. Studies examining the components coherently report a consistent increase and a considerable improvement throughout the entire childhood (eg Hale, 1990 Child Development 61 653-663; Kail, 2002 Child Development 73 1703-1714). As the used methods included a wide variety of di_erent tasks it is di_cult to compare the findings and to derive a consistent interpretation of the development of these cognitive abilities. By contrast, the present study provides a coherent interpretation of findings in the framework of TVA. Using wholeand partial-report tasks, the component functions of attention proposed in the TVA were estimated in children aged 6 to 10 years (first, second, and third grade of primary school, respectively). Results show significant increases in processing speed and vSTM capacity with increasing age. Further, the ability of top-down control is significantly more developed in third-graders compared to first-graders. In summary, the findings provide evidence for an extended global trend hypothesis assuming that all components develop in concert.
[Supported by SNSF grants PP001-110543/1 and PDFM1-114415/1 to JK]

m
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Behavioral evidence for interaction of spatial and nonspatial attention controls revealed by single paradigm
S Ohtsuka (Dept of Psychology, Saitama Institute of Technology, Japan; e-mail: satoko@sit.ac.jp)
Spatial and nonspatial attention has been largely investigated, so its function, control mechanisms, and e_ects are well known. An interrelating property of two sorts of attention, however, is still not clear. The present study aimed to explore the behavioral interaction of these attention controls. For this purpose, we adopted dual cue-target validities, based on location (spatially) and on color (nonspatiality), into a Posner type cueing paradigm. That is, the cue and target had 2 location values (left/right) and 2 color values (red/green). Participants performed location and color discrimination tasks in separate blocks. RTs were collected with 4 levels of SOAs; 200, 400, 800, and 1200 ms. In three experiments the cue was presented at peripheral, central and peripheral/central locations. As general results, the location cue showed e_ect upon RT in the location task. The e_ect included inhibitory one as well as facilitatory, except when the central location cue was presented. The e_ect became ambiguous in the color task. On the other hand, the color cue a_ected RT slightly but significantly in the color task, while it did not in the location task. These results suggest that attention controls, for spatial and nonspatial selections, are separately weighted according to task requirements.

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Conflict monitoring processes in joint attention: electrophysiological correlates of automatic gaze-following behaviour
C M Comparetti[1], E F Pavone[2], E Bricolo[1], P Ricciardelli[1] ([1]Dept of Psychology, University of Milan Bicocca, Italy; [2]Fondation S. Lucia & Dept of Psychology, University La Sapienza - Roma, Italy; e-mail: c.comparetti@campus.unimib.it)
Joint attention is manifested in an automatic tendency to follow others' gaze, a behavior modulated by context (eg presence or absence of a goal). In the present study, by combining eye-movements and ERP recordings, we investigated the involvement of two conflict monitoring processes (pre-response conflict and error detection) in joint attention. A central cue instructed participants to saccade towards one of two lateral targets. Seventy-five ms before (condition 1), or after (condition 2) instruction onset, a distracting face gazed towards a target (goal-directed), congruent or incongruent with the instructed direction; or towards an empty location (nongoal-directed). In condition1 we found faster saccadic latencies for correct trials in congruent goal-directed condition and, in the incongruent goal-directed condition, the highest proportion of gaze following errors associated with a larger amplitude of the ERN (involved in error detection). In condition 2, errors decreased significantly, but correct trials were associated with a greater N2 amplitude (involved in pre-response conflict) only in the incongruent goal-directed condition. In conclusion, our results indicate that the processes underlying automatic gaze following not only seem to be based on an early automatic and visuomotor priming but also lead to activate, at di_erent times, di_erent response conflict processes depending on the context.

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Attentional capture, modulation of voluntary orienting and grouping e_ects
M I García-Ogueta (Departamento de Psicología Básica, Universidad de Salamanca, Spain;
e-mail: ogueta@usal.es)
In previous research we have checked that transient luminance changes on a visual display capture

exogenous attention on the spatial locations where they happen. This produces costs or benefits in the thereafter processing of stimuli depending on if these appear on a congruent or an incongruent location.
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When voluntary orienting of attention—through a central spatial cue—is simultaneously deployed to a specific location, incongruent capture e_ects disappeared. We checked this modulation e_ect both in low and high perceptual load conditions of capture obtained trough di_erent number of placeholders in the previous display to stimuli. In the present research we try to study the e_ect of grouping and density on capture—something similar to crowding, not for stimuli but for capture—and orthogonal to number of placeholders. We try also to verify if the voluntary orienting modulation for incongruent capture was or not a_ected by di_erent grouping. Our results show e_ects of congruent and incongruent attentional capture on locations with di_erent number of placeholders and, at least preliminary, independent of the density and grouping. The modulation of voluntary orienting of attention again compensates incongruent capture e_ects in di_erent grouping conditions. We discuss the results according to crowding and perceptual load theories.
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Safer driving with gaze guidance
L Pomarjanschi[1,2], C Rasche[3], M Dorr[4,1], E Vig[1], E Barth[1] ([1]Institute for Neuro- and Bioinformatics, University of Lübeck, Germany; [2]Graduate School for Computing in Medicine and Life Sciences, University of Lübeck, Germany; [3]Image Processing and Analysis Laboratory, University Politehnica Bucuresti, Romania; [4]Schepens Eye Research Institute, Dept of Ophthalmology, Harvard Medical School, USA; e-mail: laura@inb.uni-luebeck.de)
Our study explores eye movements and driving behaviour in safety critical situations. For the experiment, we used a computerized driving simulator depicting realistic tra_c scenarios, involving other cars and pedestrians, inside a simulated city. We collected eye movements from subjects instructed to drive 'normally' predetermined routes while performing various cognitive tasks designed to distract the attention of the driver away from the road. Subjects were divided in two groups. The subjects in the first group were controls, while for those in the second group the potentially dangerous events triggered in the simulation were highlighted with gaze contingent cues (GCCs). Preliminary results—with 7 GCC subjects and 6 controls—show a tendency to a more homogeneous driving pattern in the case of the GCC subjects than in the case of controls. More importantly, controls were involved in 4 accidents with pedestrians, and GCC subjects in none.
[Supported by EU-project GazeCom (contract no. IST-C-033816)]
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Cueing e_ects in a useful field of view task
Y Seya[1], K I Tsutsui[2], K Watanabe[1,3], K Kimura[4] ([1]Institute of Development, Aging and Cancer, Tohoku University, Japan; [2]Graduate School of Life Sciences, Tohoku University, Japan; [3]Research Center for Advanced Science and Technology, University of Tokyo, Japan; [4]Vehicle Engineering Development Division, Toyota Motor Corporation, Japan; e-mail: seya-yasuhiro@fennel.rcast.u-tokyo.ac.jp)
In the present study, we investigated e_ects of a precue on performance of a useful field of view task, in which participants were asked to identify a character presented in a central visual field while localizing a visual target presented in a peripheral visual field. In the experiment, the precue about a location of the peripheral target was presented for a brief duration before the onset of the central character and peripheral target. Cue luminance and validity were manipulated. The results showed that, irrespective of the cue luminance, the proportions of correct responses (PCRs) to the peripheral target were higher at the cued location (valid trial) than at the uncued location (invalid trial). However, the comparisons in the PCRs between the valid and no-cue trials and between the invalid and no-cue trials showed that the cueing e_ects on the localization task changed, depending on the cue luminance. These results were discussed in terms of attentional capture by a peripheral cue.
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Visual spatial attention and developmental reading disorder: A longitudinal study
N Corradi[1], M Ru_no[2], S Gori[1], S Franceschini[1], A Facoetti[1,2] ([1]Dipartimento di Psicologia Generale, Centro di Scienze Cognitive, Università di Padova, Italy; [2]Dipartimento di NeuroPsichiatria Infantile, Istituto Scientifico 'E. Medea' di Bosisio Parini (LC), Italy; e-mail: nicola.corradi@unipd.it)
Although developmental dyslexia is often described as the result of a selective phonological deficit, visual magnocellular-dorsal (M-D) deficit hypothesis finds an increasing consent. Recent longitudinal studies pointed out that the M-D pathway plays a key role in the earliest and crucial reading acquisition phase. However, those studies do not address the exact neurocognitive mechanisms that lead from a low level impairment to a reading acquisition disorder. Grapheme–phoneme mapping requires, in addition

to awareness of speech sounds, the attentional parsing of the letters strings into their graphemes. In particular, orienting of attention—mainly controlled by the M-D pathway—through letters strings, might represent the link between M-D pathway e_ciency and reading acquisition outcome. To investigate this hypothesis, we measured in preschoolers the e_ciency in orienting visual attention to a brief spatial exogenous cue. The prereaders were followed up and classified as poor or normal readers on the base of their reading abilities development during the first grade of primary school. Both linear and logistic regressions suggest that e_ciency in orienting of visual attention is an e_ective predictor of reading acquisition outcome. These results support the hypothesis of a causal link between a spatial attention deficit and developmental dyslexia.

POSTER SESSION: COLOUR

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Target colour and texture saliency level modulate the visual P300 attentional signal: an oddball study

M P Teixeira[1], S C Nascimento[2], V M Almeida[2], M Castelo-Branco[1] ([1]Centre for Ophthalmology, IBILI, Faculty of Medicine, Coimbra, Portugal; [2]Dept of Physics, University of Minho, Braga, Portugal; e-mail: tex.marta@gmail.com)

Event related responses to infrequent and task-relevant stimuli often include an attentional peak, the P300 component. This component is typically regarded as independent from the sensory modality, with amplitude depending on target occurrence probability. In this study, we investigated whether the P300 signal could similarly be modulated by the degree of perceptual di_erence across visual target properties. We used an oddball block design with texture and colour perceptual features and frequency ratio of 1:16. For the colour condition, 3 targets with increasing steps of redness deviation were computed and, for the texture segmentation condition, 3 targets with increasing spatial phase di_erence. Colour target patches were presented against a reference background of a standard additive primary red patch, and texture patches against a standard grating one with no phase segregation contrast. EEG signal was recorded from 68 channels in 5 healthy participants (aged 23–33 years). Repeated measures analysis for target levels in midline channels revealed significant modulation of P300 amplitude, in both conditions. Significant Spearman correlations between target perceptual level and signal amplitude in parietal and frontal electrodes support this order e_ect. Therefore, we conclude that the P300 is modulated not only by target frequency but also by target saliency.

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Colour perception in scotopic stimuli

M M C Bijveld[1], M M van Genderen[1], F P Hoeben[1], A M L Kappers[2], F C C Riemslag[1] ([1]Bartiméus, Institute for the Visually Impaired, The Netherlands; [2]Physics of Man, Helmholtz Institute, Utrecht University, The Netherlands; e-mail: mbijveld@bartimeus.nl)

In this study we investigated cone activity at very low scotopic intensities, far below the commonly accepted cone threshold. To that end, we recorded electroretinograms (ERGs) to 15 Hz flicker stimuli of di_erent colours. Furthermore, we determined the subjective threshold of colour perception. The ERGs to 15 Hz flicker stimuli of increasing intensities showed two minima. We hypothesize that the first is caused by rod-rod interactions and the second by rod-cone interactions. In accordance with previous studies we could confirm that at intensities around the first minimum there is no significant cone contribution to the ERGs. For the colour perception experiment, we randomized 15 Hz stimuli of di_erent colours and low scotopic intensities and asked subjects to indicate the colour of the stimulus and the confidence about their answer. Remarkably, perception of colour was above chance at all intensities. At intensities around and above the first minimum subjects hardly made any mistakes and were confident about their answer. This may indicate cone activity at intensities that show no cone contribution to the ERG. Alternatively, rods mediate colour perception at low intensities.

[This study is partially funded by ODAS]

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Individual di_erences in the organisation of post receptoral colour mechanisms

A J Lawrance-Owen, J D Mollon (Dept of Experimental Psychology, University of Cambridge, UK; e-mail: ajl69@cam.ac.uk)

A variety of experimental techniques point to the existence of higher order colour mechanisms tuned to many directions in colour space, these are viewed as recombinations of the three channels found at the lateral geniculate nucleus [Eskew, 2009 Vision Research 49(22) 2686-2704]. We investigated these higher order mechanisms because of the suggestion of bimodal individual di_erences in the distribution of such channels [Webster and Mollon, 1994 Vision Research 34(15) 1993-2020]. Twenty participants

were adapted to modulations in colour contrast and the e_ect on colour appearance was measured using an asymmetric matching task. Adaptation reduced the saturation of all colours but was selective: e_ects were greater for hues in same direction as the adapting stimulus. The mean reduction in saturation was 62% in the adapting direction, 25% in the orthogonal direction. There were large individual di_erences, with a three-fold variation in the degree of selectivity. Test-retest reliability was 0.69. However, individual subjects were normally distributed, not bimodally, as originally suspected. The results could be explained by some individuals possessing many intermediate channels whereas others possess only those channels tuned to the cardinal directions.
[Supported by the Gatsby Charitable Foundation]

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Evidence that local cues limit shape discrimination at threshold in color and luminance vision
I V Ivanov, K T Mullen (McGill Vision Research, McGill University, Montreal, Canada;
e-mail: iliya.ivanov@mcgill.ca)
A key aspect of simple shape processing is the binding of distributed local features into an overall form, with a progression from a local to global analysis. Threshold measurements of shape discrimination may be limited, however, at either the local or the global stage. Here we test the importance of local cues in limiting shape discrimination thresholds in chromatic and achromatic vision. Stimuli are radial frequency patterns (SF=0.75–3 cpd) defined in chromatic (RG) or achromatic contrast. In di_erent experiments we investigated: (1) Performance on local parts of the pattern (corners, sides) compared to the whole pattern; (2) The e_ect of scaling of the pattern; (3) The e_ect of linear (local curvature preserved) vs nonlinear transforms (local curvature varies) of the pattern. The results of Experiment 1 show no change in shape discrimination thresholds for single features vs the whole pattern, supporting a local analysis. Experiment 2 reveals an e_ect of scaling on discrimination thresholds, arguing against a global analysis, and Experiment 3 shows that discrimination thresholds are robust across linear transformations of the shape but vary with nonlinear transformations, suggesting the importance of local curvature analyses at threshold. We conclude that threshold shape discriminations may reveal local rather than global limitations.
[This study was funded by a CIHR grant to K.T. Mullen (MOP-10819)]

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Slowdown of gist perception in colour diagnostic scenes
D Stricker, M T Groner (Dept of Psychology, University of Bern, Switzerland;
e-mail: daniel.stricker@psy.unibe.ch)
Humans perceive the content (gist) of a scene very rapidly within about 40 ms [Castelhano and Henderson, 2008 Journal of Experimental Psychology Human Perception and Performance 43(3) 660-675]. It has also been demonstrated that colours contribute to the perception of the gist of a scene if the colours are diagnostic for the distinction of scenes (Oliva and Schyns, 2000 Cognitive Psychology 41 176-210). We presented 320 coloured photographs of 2 diagnostic (mountains and coasts) and 2 nondiagnostic colour scenes (cities and rooms), 80 per category, in a masking paradigm. The mask consisted of randomly distributed colour patches. SOA was varied between 20 and 80 ms, in steps of 20 ms and subjects had to indicate the gist of the scene (4AFC). A control condition without masking was also included. In line with previous results we have found that the gist of nondiagnostic coloured scenes is extracted within 40 ms. However, if colour comes into play, the extraction of the scene gist is prolonged by about 20 ms. A possible reason for this outcome might be that nondiagnostic colour scenes are identified by their luminance components which are processed faster than the colour information, which in turn mediates the identification of diagnostic colour scenes.

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Hue discrimination to spectrally modulated lights
R Bachy[1], J Dias[2], D Alleysson[2], V Bonnardel[3] ([1]Computer Science department, UPMC, Paris, France; [2]Laboratoire de Psychologie et Neurocognition, Université Pierre Mendès France Grenoble, France; [3]Dept of Psychology, University of Winchester, UK;
e-mail: romain.bachy@gmail.com)
Using sinusoidally modulated spectral power distributions (SSPDs) defined by their frequency (f : cycles/300 nm), phase (p: degrees) and amplitude (m), we measured the minimum phase di_erence (_p) to discriminate two SSPDs of fixed frequency (1.5 cycles) and amplitude (m=1). Our light stimulator [Bonnardel et al, 1996 Vision Research 36(17) 2713-2720] produces a 2° spot of 1 cd m^{-2}. In a 3AFC, hue sensitivity thresholds of two observers were measured under two light adaptation conditions (x=0.27; y=0.27 and x=0.37; y=0.36) for 12 di_erent phases varying from 0 to 360° whose chromaticities describe

an elliptical contour in a chromaticity diagram . Empirical discrimination curves (_p/p) are explained by a 3-stage Müller-zone model with a von Kries adaptation. A linear model (A+B cos(2kp+K), with K

depending on adaptation) predicts post-receptoral mechanism parameters and adapting function. For a given phase, SSPD dominant wavelength is determined and discrimination curves expressed in function of wavelength (__/_) show similar profiles to wavelength discrimination curves obtained under di_erent adapting lights (Hurvich and Jameson, 1964 Vision Research 4 135-154). Spectrally modulated lights allows us to generalise hue discrimination characterisation to non-spectral hues (ie hues located on the alychne).

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Towards a general model of colour categorization which considers context

C A Parraga, R Benavente, M Vanrell (Computer Vision Centre, Computer Science Dept, Universitat Autònoma de Barcelona, Spain; e-mail: alejandro.parraga@cvc.uab.es)

In two previous experiments [Parraga et al, 2009 J. of Im. Sci. and Tech 53(3) 031106; Benavente et al, 2009 Perception 38 ECVP Supplement, 36] the boundaries of basic colour categories were measured. In the first experiment, samples were presented in isolation (ie on a dark background) and boundaries were measured using a yes/no paradigm. In the second, subjects adjusted the chromaticity of a sample presented on a random Mondrian background to find the boundary between pairs of adjacent colours. Results from these experiments showed significant di_erences but it was not possible to conclude whether this discrepancy was due to the absence/presence of a colourful background or to the di_erences in the paradigms used. In this work, we settle this question by repeating the first experiment (ie samples presented on a dark background) using the second paradigm. A comparison of results shows that although boundary locations are very similar, boundaries measured in context are significantly di_erent (more di_use) than those measured in isolation (confirmed by a Student's t-test analysis on the subject's answers statistical distributions). In addition, we completed the mapping of colour name space by measuring the boundaries between chromatic colours and the achromatic centre. With these results we completed our parametric fuzzy-sets model of colour naming space.

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Heterochromatic flicker perception in the periphery substantially deviates from central vision

M Perz[1,2], R H Cuijpers[1], D Sekulovski[2] ([1]Human Technology Interaction, Eindhoven University of Technology, The Netherlands; [2]Philips Research Europe, The Netherlands; e-mail: gosia.perz@philips.com)

Colour transitions in peripheral vision can reveal unexpected intermediate colours or flicker. Presumably, the CIE colour spaces used to generate these colour transitions are incorrect for peripheral vision. We investigated detection thresholds for heterochromatic flicker for eccentric viewing angles of 35, 60, and 90°. We modulated the colour of a red, green and blue base colour (L*=C*=60, h*=45, 150, 290) with varying flicker frequencies (5–40 Hz). We independently varied the modulation amplitude in the lightness, chroma and hue directions as defined by the CIE L*C*h* colour space. We found similar results for all three base colours when modulating lightness. Detection thresholds typically increase with flicker frequency. Comparing across eccentricities we found that detection of luminance flicker breaks down at 40 Hz and above for a 90° eccentricity. A similar pattern is found when modulating hue and chroma, except that the thresholds are about 10 times larger than for lightness. Surprisingly, we find large di_erences for the di_erent base colours even in the far periphery. Observers are relatively insensitive to modulation of hue and chroma around the red and green base colour, respectively. These results show that the CIE L*C*h* colour space is far from perceptually uniform in the periphery.

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Strength judgment of filling-in color aftere_ect illusion for di_erent shapes

S Fomins, N Rileyeva-Piskura, M Ozolinsh (Optometry and Vision Science Dept, University of Latvia, Latvia; e-mail: sergejs.fomins@gmail.com)

The strength of chromatic aftere_ect was studied based on the filling-in aftere_ect image illusion [Van Lier et al, 2009 Current Biology 19(8) 323-324]. Round and sharp edged overlapping chromatic figures are presented to subjects for 1.2 s on the both sides of fixation point. After 1.2 s the empty shapes of the figures appear for 0.6 s and change orientation on both sides of the fixation point producing the change of the aftere_ect color from side to side. Subjects made judgments about the strength of the perceived aftere_ect on the ten-grade scale for di_erent color pairs. The color of one of the figures was kept constant while the color of other figures was changed and the change of both color stimuli gave

measurements for 192 pairs in total. Our findings show that opponent colors mostly lye on opposite side of CIE L*a*b* color space. Some color pairs aroused powerful sensation of aftere_ect with color not directly arranged on the opposite axis of color space. This di_ers from our previous findings (Atvars and Fomins, 2009 Perception 38 ECVP Supplement, 185). No significant changes were observed for round

and sharp edged design stimuli.
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The e_ect of colour on retrieval of textual information

S Z Zaidi, A Ojha, B Indurkhya (IIIT, International Institute of Information Technology, Hyderabad, India; e-mail: saniazehrazaidi@gmail.com)

New teaching methods to represent information have greatly replaced the more conventional 'textbook learning'.With information being represented in various forms it becomes important to see what kind of representation works best to facilitate better learning and retention. Impact of colors, as well as contrast on aesthetic experience, memory and on intention has been studied (Hall and Hanna, 2004). Studies by Kiritani & Shirai (2003) show that readers felt time passed slowly when text was read on a white, blue or green background. In this research we studied the e_ect of background color on the retrieval of information and whether gender has a role to play in the selection of color leading to higher recall.We hypothesise that higher contrast between background and textual information helps in longer retention. The experiment was conducted on computer science engineering students who were presented textual information on two di_erent backgrounds (cool and warm) with varying contrasts. The results indicate that when the contrast ratio between background and text is high (above 15) the percentage of recall is high irrespective of gender(conforming our hypothesis), with the highest being for black background and white text (contrast ratio 21). In addition to this when contrast is low, cool backgrounds (indigo, teal) helped females in better retrieval and for males warm backgrounds (pink, crimson) gave the same result. The di_erence in gender was statistically significant $F_{2,28}=5.76$, $p<0.01$.

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Illusory motion of blurred blue–red edges

K Takahashi[1,2], R Niimi[1,2], K Watanabe[1,3] ([1]Research Center for Advance Science and Technology, University of Tokyo, Japan; [2]JSPS, Japan; [3]AIST, Japan; e-mail: takahashi.kohske@gmail.com)

When observers make saccades over a blurry red (blue) figure against a blue (red) background, they experience illusory motion of the figure in the direction opposite to saccades. Through a psychological experiment asking observers to rate the subjective strength of the illusory motion, we confirmed that (1) the illusory motion did not take place when the figure edge was sharp, (2) the illusion was colorselective: little or no illusory motion for color combinations other than red–blue, (3) the magnitude and the perceived direction of the illusory motion for red-against-blue figure and those for blue-against-red figure were comparable, and (4) the illusion took place even in the fovea. Importantly, we also found that (5) physical motion of the visual pattern including blurry edges itself induced the illusory motion without eye movement. The illusion may provide a new insight on the interaction between color vision, especially the process for red–blue contrast, and motion perception.

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Preconscious priming under transparency illusions of brightness and color

A Weber, T Schmidt (Dept of Psychology I, Faculty of Social Sciences, University of Kaiserslautern, Germany; e-mail: andreas.weber@sowi.uni-kl.de)

Perceived brightness of objects depends on the context in which they are presented (lightness constancy). Schmidt et al (in press Attention, Perception, & Psychophysics) demonstrated qualitative dissociations of brightness processing in visuomotor priming and conscious vision using flanker primes and targets under visual illusion conditions. We replicated this results with flankers apparently presented behind transparent surfaces. Priming e_ects could systematically contradict subjective brightness judgments about the flankers, such that one flanker perceptually appears to be brighter than the other, while it primes as if it was darker. A follow-up experiment examines comparable findings for color flankers apparently behind transparent, colored surfaces. The interesting question is whether greenish flankers trigger responses like reddish flankers if they are located closer to the red pole of a bipolar (green–red) dimension in color space than its immediate (filtered) background. We conclude that response priming e_ects are independent of subjective brightness/color of the flanker and only depend on the local luminance/color contrast between flanker and background.

[Schm1671/1-5]

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Age di_erence in color combination perception

H R Kim[1], J H Kim[1], J W Kim[2], H S Kim[1], K H Han[3] ([1]Graduate Program in Cognitive Science, Yonsei University, South Korea; [2]Dept of Psychology, University of South Carolina, USA; [3]Dept of Psychology, Yonsei University, South Korea; e-mail: heheday@naver.com)

Kobayashi's color combination image scale, which allocates color combinations on two-dimension [soft–hard (SH) and warm–cool (WC)] and visually represents their emotional values, has been not fully verified psychologically and statistically, contrary to color image scale. This study investigated the e_ects of SH and WC of the Kobayashi's scale on 'perceived SH' and 'perceived WC' in relation to age. Among the color combinations on Kobayashi's color image scale, 9 combinations were selected as stimuli representing 3 levels of SH and WC from a pilot study. For observing age-related di_erences we recruited 2 age groups; younger (20–30 years old) and older adults (over 55 years old), and measured perceived SH and WC. The results indicated that WC has an e_ect on 'perceived SH', whereas SH does not a_ect 'perceived WC'. Specifically, warm-soft stimulus was perceived softer than cool-soft stimulus although they have similar SH values on Kobayashi's scale. We found positive correlation between perceived SH and WC in all of the stimuli, except neutral-warm, hard-warm, and hard-neutral conditions. When it comes to age, the e_ect of WC on 'perceived SH' was found only in young participants. Younger group perceived warm–soft stimulus softer than cool–soft stimulus, but older group perceived that they had similar degree of softness. We also found the significant interaction between WC and age on 'perceived WC', which shows that the young perceived WC more sensitively than the old. Overall distribution of older group's responses is narrower than younger group's distribution, especially in the dimension of WC, which can be inferred from more centered response pattern in old people. This means old people are less responsive to the WC level of color image. The correlation between two dimensions and the age di_erence of WC sensitivity are discussed.

[This study has been supported by Yonsei university and Brain Korea 21]

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Color constancy test: the method for assessment of functional state of color constancy mechanisms

D Janelidze, M Khomeriki, N Lomashvili, A Kezeli (Dept of Behavior and Cognitive Functions, I.Beritashvili Institute of Physiology, Georgia; e-mail: david.janelidze@gmail.com)

We developed a test to measure color constancy for illumination shifts. First, we presented color samples with a white illumination and then increased chromaticity stepwise. Subjects were asked to report the chromaticity at which a given color sample changed to a di_erent color category. We consider this value as a threshold for color constancy. Some color samples transited into another monochromatic category directly while in other cases binary colors appeared. The existence of binary colors made the precise determination of color category transition points—ie thresholds—much more complex. In these cases, subjects were asked to determine when binary colors transited into a monochromatic category by further elevation of chromaticity. This approach yielded much less discrepancy in the data. Hence, the level of chromaticity does not always represent an absolute threshold for a given color, namely, in the case where binary colors are perceived. Nevertheless, thresholds measured in this way can be used for assessing color constancy mechanisms.

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Colour preference argues against a dorsal component of human V4

E Goddard[1,2], D M Mannion[1,2], J S McDonald[1], S G Solomon[3,2], C W G Cli_ord[1,2] ([1]School of Psychology, University of Sydney, Australia; [2]ARC Centre of Excellence in Vision Science, University of Sydney, Australia; [3]School of Medical Sciences and Bosch Institute, University of Sydney, Australia; e-mail: erin.goddard@sydney.edu.au)

High resolution functional MRI enables the reconstruction of retinotopic maps in human visual cortex, but the organisation of these maps remains controversial. A critical debate is the location of the human homologue of macaque area V4, an area very responsive to coloured images: specifically whether V4 is divided between ventral and dorsal components, as in macaque, or whether in human the entire hemifield is represented in one ventral area. To address this we mapped responsivity to colour in the widely accepted ventral region of V4 and its putative dorsal component. We acquired functional images of occipital cortex while participants (N=6), viewed coloured vs black and white movie excerpts. We found a robust colour preference in ventral V4 and surrounding areas, and little or no colour preference

in the vicinity of the dorsal counterpart. Our results argue against the existence of a dorsal component of V4 and for a ventral representation of the entire hemifield.

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The contribution of colour to coherent motion of second-order RDKs

L Garcia-Suarez, K T Mullen (McGill Vision Research, Dept of Ophthalmology, McGill University, Canada; e-mail: luis.garciasuarez@mail.mcgill.ca)

Previous evidence suggests that higher-order motion mechanisms are preserved in colour vision. Here, we investigate the contribution of colour to global motion processing using second-order (contrastdefined)

random dot kinematograms (RDKs). Second-order RDKs were composed of multiple circular disk envelopes (1.6° in diameter, smoothed with a raised cosine) that modulated the contrast of lowpassed filtered carrier noise backgrounds (12° in diameter). Stimuli were achromatic or isolated the L/M cone opponent (isoluminant red-green) mechanism. We compared simple detection and motion discrimination thresholds (at 100% motion coherence) using a simultaneous detection and motiondirection discrimination 2-AFC paradigm. We then measured global motion performance by varying limited-lifetime RDK motion coherence levels. We found that, for all observers (N=3), direction discrimination thresholds were higher than modulation detection thresholds of the RDKs for both luminance and red-green stimuli. The gap between these thresholds was greater for the chromatic than the achromatic stimuli and direction discrimination thresholds for the chromatic condition were very high or impossible to obtain even at 100% coherence. Global motion thresholds (varying %-coherence) could only be obtained for achromatic stimuli. We find no global motion processing of second-order stimuli, probably because second-order motion perception for RDK elements is very poor or non-existent.
[Supported by Canadian NSERC grant (RGPIN 183625-05) to KTM]

POSTER SESSION: FACE PERCEPTION I

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Does the Muslim headscarf impair face recognition?
M U Toseeb[1,2], D R T Keeble[1,2], E J Bryant[2] ([1]Bradford School of Optometry and Vision Science, University of Bradford, UK; [2]Centre for Psychology Studies, University of Bradford, UK; e-mail: U.M.Toseeb@Bradford.ac.uk)
The Muslim headscarf (hijab) conceals the hair and other external facial features, and so may have implications for the ease with which faces are remembered. To investigate this, 24 South Asian females were photographed wearing the headscarf (HS), with their own hair (OH) visible, and with all external features cropped (CR). Participants viewed a number of photographs during the learning phase and then subsequently viewed the same faces intermixed with distracter faces. Participants were required to decide whether each face had been seen in the learning phase. Crucially, faces were either in the same state in the two phases, or switched between two di_erent states. Surprisingly, when the hair state was the same at learning and test, performance was almost the same (approximately 83%) for OH, HS, and CR conditions. However, when the hair status of the pictures was switched between learning and test phases, performance dropped dramatically to approximately 64%. No di_erences were found between participants of di_erent races and genders. These results imply that there is su_cient information in the internal features of faces for optimal performance in these experimental conditions. The drop in performance when hair status changes suggests that the hijab or hair may sometimes act as a perceptual mask to the face stimulus, in much the same way that a wig can act as a disguise in certain circumstances.

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The Belladonna Illusion: Changing attraction via a motion aftere_ect
C A Sutherland, R Jenkins, M Burton (Dept of Psychology, University of Glasgow, UK; e-mail: cam.sutherland@ntlworld.com)
Psychological studies of first impressions often overlook the important distinction between subjective attractiveness (‘attractive to me’) and objective attractiveness (‘attractive to other people’. Given that pupil size has been shown to index physiological arousal and is considered to signal sexual interest (Tombs and Silverman, 2004 Evolution and Human Behaviour 25 221-228) we predicted that pupil dilation in a seen face would influence subjective but not objective attractiveness ratings (the ‘Belladonna Illusion’). To test this, we developed a new technique for manipulating dynamic pupil dilation in a highly controlled fashion. Participants used a Likert scale to rate subjectively and objectively the attractiveness of photographs of female faces. Each photograph was preceded by a rotating spiral positioned over the pupil area. Adaptation to the spiral induces a powerful aftere_ect of expansion or contraction (opposite to spiral rotation) which is spatially restricted to the pupil. Ratings were significantly higher in the

expanding pupil condition than for contracting pupils, demonstrating for the first time an illusory (motion aftere_ect) Belladonna e_ect for physically identical stimuli. Finally, this di_erence only existed for the subjective ratings, presumably as the apparent change in arousal level is attributed to eye contact.
[The project was supported by EPS and BPS undergraduate bursaries to CS]

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Developmental changes in the speed of face processing
B Meinhardt-Injac[1], J Zöllig[1], M Persike[2], M Martin[1], G Meinhardt[2] ([1]Dept of Psychology, University of Zurich, Switzerland; [2]Dept of Psychology, Methods Section, University of Mainz, Germany; e-mail: b.meinhardt@psychologie.uzh.ch)
In the present study we aimed to reveal whether children and adults di_erentially weight configural and featural facial information and to estimate the speed of face processing by adults and children. The proportion of correct responses as a function of stimuli exposure time was measured in school

children (age 7–11) and adults (age 20–37). In a sequential same/di_erent task identity of pairs of unfamiliar faces was judged based on external (hair, head and face outline) or internal (eyes, eyebrows, nose, mouth) features, while the unattended feature type was either congruent or conflicting with the expected identity judgment. Overall, the results reveal a predominantly configural nature of adult's face processing regime, as opposed to more feature based mechanisms underlying children's face processing. There is also a strong asymmetry in adults' and children's performance depending on the feature class. A large discrepancy was observed for the performance in matching internal, but not external features. Additionally, we demonstrate that children and adults di_er not only in the information they preferentially encode in a face, but also in the processing time they need to combine visual inputs into a representation of a face.

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No other-race e_ect found in a task using faces di_ering only in race-specifying information

I Bültho_[1,2], R Lee[2], R Armann[1], C Wallraven[1,2], H H Bültho_[1,2] ([1]Dept of Human Perception, Cognition and Action, Max Planck Institute for Biological Cybernetics, Tübingen, Germany; [2]Dept of Brain and Cognitive Engineering, Korea University, South Korea; e-mail: isabelle.bueltho_@tuebingen.mpg.de)

Generally, faces of one's own ethnicity are better remembered than faces of another race. The mechanisms of this other race e_ect (ORE) are still unresolved. The present study investigates whether expertise for own-race results in ORE in a discrimination task when only race-specifying information varies between faces, with no interference of identity change and no memory load. If expertise is an important factor for ORE, Caucasian participants, for example, should better discriminate between two Caucasian faces presented side by side than between two Asian faces. We tested participants in Seoul and Tübingen with pairs of Asian or Caucasian faces. Their task was to tell which face of the pair was either more Asian or more Caucasian. Although we found that Asian face pairs were unexpectedly but consistently better discriminated than Caucasian faces, this Asian advantage did not di_er between both city groups. Our results show furthermore that Seoul and Tübingen participants' discrimination performance was similar for Asian and Caucasian faces. These findings suggests that when there is no memory component involved in the task and when face appearance only di_ers in race-specifying information, own-race expertise does not result in better performance for own-race faces.

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Humans are handy at sex discrimination: A new tool for discriminating vision-based sensitivity to another's sex

A R Brooks, J Gaetano, R van der Zwan (Laboratory of Cognitive Neuroscience and Behaviour, Southern Cross University, Australia; e-mail: anna.brooks@scu.edu.au)

Sexing another individual based purely on sparse visual input is an ability of which the human observer is eminently capable. Robust evidence of that capability arises from a range of studies using both motionbased (eg Barclay et al, 1978 Perception & Psychophysics 23 145-152) and static body representations [eg Reddy et al, 2004 Journal of Vision 4(2):4, 106-117]. In relation to the latter, quantification so far has been achieved primarily through the use of a single stimulus set: human faces. Here, we report for the first time data supporting the viability of an additional set: human hands. Our data indicate an exquisite level of observer sensitivity to sex based purely on static two-dimensional representations of adults' hands. Indeed, such is that sensitivity that it manifests across a range of stimulus orientations and presentation durations. Implications of our findings for research into neural representations of sex (gender), as well as for face neuroimaging studies in which the search for suitable control stimuli has so far been illusive, are discussed.

Poster session: Face perception I

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Body context can influence search for faces

K J Proctor[1], J Evans[1], K S Pilz[2], I M Thornton[1] ([1]Dept of Psychology, Swansea University, UK; [2]Dept of Psychology, Neuroscience and Behaviour, McMaster University, Hamilton, Canada; e-mail: 519643@swansea.ac.uk)

Faces are typically experienced in the context of a body that moves in space. Previously we used computer-animated stimuli to demonstrate advantages for faces that approached the observer as part of a moving body (Pilz et al, 2006 Perception 35 420-420). Here we ask whether this e_ect a) generalizes to live-action video, and b) is modulated by facial expression. Actors were dressed in surgical scrubs and filmed walking along a hallway directly towards the camera. One sequence was filmed with smiling expressions, another while frowning. During familiarization, participants saw clips of two actors; one moving, one static. The clips alternated on the screen while participants completed a brief questionnaire on facial characteristics. The identity of dynamic and static targets, and their facial expression were counterbalanced across 4 separate groups of participants. At test, all participants performed the same visual search task on novel, static images, responding present if either target face appeared. Set sizes

were 2, 4, or 6 items and targets were present on two thirds of trials. There were reliable response time (415 ms) and accuracy (3%) advantages for dynamically learnt faces, replicating our finding with computer-animated stimuli. Facial expression did not modulate this pattern of results.

m

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Texture coding in the fusiform ace area

K V Haak[1,2], R Renken[1,2], J B C Marsman[1,2], F W Cornelissen[1,2] ([1]Laboratory for Experimental Ophthalmology, University Medical Center Groningen, The Netherlands; [2]BCN Neuroimaging Center, University of Groningen, The Netherlands; e-mail: k.v.haak@med.umcg.nl)

The fusiform face area (FFA) is a region in human occipito-temporal cortex specialized for face perception [Kanwisher et al, 1997 Journal of Neuroscience 17(11) 4302-4311]. Recent evidence suggests that the FFA is not only sensitive to configural aspects of faces but also to textural information (Cant and Goodale, 2007 Cerebral Cortex 17 713-731). This is consistent with the notion that surface properties such as color and texture may be particularly useful for discriminating among faces (Russell and Sinha, 2007 Perception 36 1369-1374), characterizing skin pigmentation (Russell et al, 2004 Journal of Vision 418a 4) and determining facial attractiveness [Fink et al, 2001 Journal of Comparative Psychology 115(9) 92-99]. Here, we further explore texture coding in the FFA. Using functional magnetic resonance imaging (fMRI) of repetition suppression we investigated whether texture coding in the FFA is robust to changes of the retinal image. Our results indicate that bilateral FFA is sensitive to di_erent texture stimuli but not to the di_erent orientations and scales at which these were presented. Based on this, we propose that neural representations in the FFA reflect configural information as well as the image statistics that distinguish textures.

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m

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Curve adaptation e_ects on high-level facial-expression judgments are predicted to have the same form as low-level aftere_ects

C Zhao, J A Bednar (Institute for Adaptive and Neural Computation, University of Edinburgh, UK; e-mail: C.Zhao-3@sms.ed.ac.uk)

Hong Xu et al. [Hong Xu et al, 2008 Journal of Neuroscience 28(13) 3374-3383] recently showed that adaptation to curved lines can a_ect high-level perception of emotional a_ect in faces, presumably by modifying the perception of mouth curvature. For the patterns tested so far, the e_ect increases as the adaptation pattern curvature increases. However, standard low-level aftere_ects like tilt and motion aftere_ects (TAE & MAE) typically show an S-shaped curve, with a decline in aftere_ect strength for test patterns su_ciently di_erent from the adaptation stimulus. In computational models of the TAE, the S-shape reflects adaptation in neurons that prefer a particular orientation, with neurons preferring very di_erent orientations having little adaptation and thus showing weaker aftere_ects. To see whether a similar explanation might apply to curvature/emotion aftere_ects, we adapted an existing model of the TAE for use with curved lines and added processing for emotion judgments. We found that the model replicated the existing data on high-level e_ects of low-level adaptation, but strongly predicted an S-shape, ie that su_ciently large curvature values would lead to a lower e_ect. This prediction can be tested in humans, potentially helping to constrain the properties of the neurons underlying the e_ect.

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Poster session: Face perception I

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Configural load of emotional expressions

A Fried[1], M Persike[1], G Meinhardt[1], B Meinhardt-Injac[2] ([1]Dept of Psychology, Methods Section, University of Mainz, Germany; [2]Dept of Psychology, University of Zurich, Switzerland; e-mail: fried@uni-mainz.de)

Face processing di_ers significantly from processing of other objects (eg Maurer et al, 2002). Particularly processing of emotional expression relies heavily on configural clues, as well as on individual features. Here we study the impact of configural clues on the identification of the six basic facial expressions of emotion (anger, disgust, fear, sadness, happiness and surprise). In order to measure the impact of feature integration across the whole face the composite face paradigm was used (Young, 1987; Richler et al, 2009) and applied to 16 face models of the Pictures of Facial A_ect (Ekman and Friesen, 1976) database. Identification of positive emotions (happiness, surprise) was found to be generally less a_ected by just part based processing, while correctly recognizing negative emotions much stronger depends on intact wholes. Building a ranking order of emotions with respect to the size of the composite e_ect gives stable results for the sample, but not when evaluated on a within subject basis. These results suggest that it is possible to classify emotions as more or less ‘featural’ and ‘configural’, but they also indicate a large interindividual variance in the integration of face parts.

m

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The e_ect of facial distinctiveness on attentional processing
N Takahashi[1], H Yamada[2] ([1]Graduate School of Literature and Social Science, Nihon University, Japan; [2]College of Humanities and Sciences, Nihon University, Japan;
e-mail: nonname34@live.jp)
It has been widely known that unfamiliar faces which are perceived as distinctive or unusual are more accurately recognized in a memory experiment. Such a result might be considered to come partly from the e_ects of facial distinctiveness on attentional processes. To test this view, Ryu and Chaudhuri (2007 Perception 36 1057-1065) examined the di_erences in attentional performance between distinctive faces and typical ones in two di_erent attentional tasks that induced attentional blink, and suggested from their results that distinctive faces are associated with greater processing e_ciency. The present study investigated the e_ects of facial distinctiveness on attentional processes in two di_erent attentional tasks: change-detection task and face-identification task. The first change-detection task required participants to detect changes that occurred between two pairs of faces within 500 ms. Changes involving the distinctive face of a pair tend more likely to be detected than those involving a typical face. The second face-identification task required participants to identify either a distinctive or a typical face embedded in each of RSVP sequences. The identification accuracy of distinctive faces were not consistently higher than typical faces. We will discuss our results with respect to the attentional e_ciency of faces.

m
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First-order interference in a face discrimination task for nonhuman primates
D Aagten-Murphy[1], J Taubert[2], L A Parr[2] ([1]Dept of Psychology, University of Florence, Italy; [2]Yerkes National Primate Research Center, Emory University, USA; e-mail: murfs.au@gmail.com)
Face discrimination is a complex task that requires 'first-order information', to distinguish faces from other visual objects, and 'second-order information', to make fine comparisons between faces. However, how these two processes interact and the importance of the first-order configuration (a mouth, below a nose, below two eyes) for discrimination has not yet been fully addressed. Twelve subjects [six chimpanzees (Pan troglodytes) and six rhesus monkeys (Macaca mulatta)] were trained to discriminate either canonical whole or scrambled faces. Scrambled faces were created by the subtraction and then addition of gaussian filtered local areas centered on key features to create smooth transitions between scrambled features. Subjects were then examined on their ability to transfer their expertise to conditions with identical first- and second-order information, identical second-order only or novel configurations of the same identity. Consistent with holistic processing for whole faces, the data suggests that the presence of the canonical configuration changed the perception of local features. Furthermore both species preferentially performed the individual discrimination task using first-order information, not the second-order variation typically assumed to underline discrimination. We suggest the canonical configuration is essential in the rapid detection and identification of faces and involves the involuntary integration of key facial features.
Poster session: Face perception I
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An own-age bias in age estimation of faces in children and adults
E V Moyse, S J Brédart (Center for Cognitive and Behavioural Neuroscience, University of Liège, Belgium; e-mail: evelyne.moyse@ulg.ac.be)
The aim of the present study was to assess the occurrence of an own-age bias on age estimation performance (better performance for faces from the same age range as that of the beholder) by using an experimental design inspired from research on the own-race e_ect. The age of the participants (10 to 14 year old children and 20 to 30 year old adults) was an independent factor that was crossed with the age of the stimuli (faces of 10 to 14 year old children and faces of 20 to 30 year old adults), the dependent measure being the accuracy of age estimation. There were 30 participants in each age group. An interaction between the two factors was expected. A two-way 2 (age of the participants)×2 (age of the stimuli) ANOVA with repeated measures on the last factor was carried out on the accuracy scores. This analysis revealed a main e_ect of age of the participants and of age of the stimuli, and an interaction between these two factors. Children's performance was less accurate when estimating the age of adults' faces compared with children's faces. However, in both age groups, accuracy was better for children's faces than for adults' faces.

m
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Cues of being watched enhance pro-social attitudes
V M Hesslinger, C-C Carbon (Dept of Psychology, University of Bamberg, Germany;
e-mail: ccc@experimental-psychology.com)
Bateson et al. (2006 Biology Letters) presented a demonstration of what behavioral impact biological cues such as eye-pairs might have: people paid nearly three times as much for their drinks o_ered by a non-observed self-service system when eyes were displayed rather than a control image showing flowers. The authors attributed the pro-social behavior to the fact that participants had the feeling of

being watched. Despite its relevance the original study su_ers from some shortcomings, for instance participants were not tracked, but only money was counted, no alternative behavioral measures were used, and no personality tests of the involved persons were conducted. We replicated the study with a higher N (136) confronting half of them with two pictures of an eye-pair depicting an angry young male and the other half with two flower pictures with the same configuration as the eye pair. On the same sheet, participants were asked items on prosociality, altruism, free will, moral courage and handwashing behavior. A previously conducted personality test ensured no significant di_erences in any of the big-five personality factors. According to Bateson et al. participants showed higher pro-social attitudes when confronted with the eye-pair, thus underlining the relevance of biological cues as social signal.

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Reduction of facial emotion processing in congenital prosopagnosia

R Lüdtke[1], T Grüter[1], B Derntl[2], M Grüter[3], C-C Carbon[1] ([1]Dept of Psychology, University of Bamberg, Germany; [2]Faculty of Psychology, University of Vienna, Austria; [3]Münster, Germany; e-mail: ramona.luedtke@gmx.de)

Congenital prosopagnosia (cPA) is a selective impairment in identifying faces that is present from birth. The face recognition problems occur despite intact visual and intellectual function. Here, we investigated the ability of recognizing emotions in a group of seven patients with cPA diagnosed by a standardized semistructured interview. In an emotion-recognition task, faces of both genders showing five basic emotions (anger, disgust, fear, happiness, and sadness) as well as neutral expressions were presented in upright or inverted orientation. We found that in the upright condition, the recognition accuracy of the cPA group was significantly lower in comparison to the control group, especially for the emotional expressions disgust and happiness and for neutral expressions. There were no di_erences in the recognition rate between the groups in the inverted condition, though. Furthermore, a pronounced di_erence in reaction time was measured: prosopagnosic subjects tended to answer faster and showed less variation in reaction time. Obviously, people with cPA not only exhibit identification problems but also demonstrate a restricted emotion recognition rate in upright faces. This might indicate a specific impairment of configural processing as demonstrated for Thatcher faces, relationally manipulated faces and an attractiveness-distinctiveness decision task, conducted in previous works.

m

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Humans make similar errors as computational algorithms when detecting faces

B M 't Hart, T Abresch, W Einhäuser (AG Neurophysik, Philipps-Universität Marburg, Germany; e-mail: thart@sta_.uni-marburg.de)

Faces appear to be processed by the human visual system as a special class of stimuli. To what extent faces constitute an 'elementary' feature of early processing has, however, remained controversial. Augmenting an attention model with the Viola and Jones (2001) face-detection algorithm to improve its

prediction of fixated locations has recently supported this view. Here we investigate whether this result extends to ultra-rapid face detection by comparing the algorithm´s output to human errors. Stimuli were gathered from first person perspective movies and split into three sets: real faces (hits of the algorithm), 'hallucinated' faces (false positives), and non-faces (correct rejects). Observers were shown a pair of stimuli for 20 ms, followed by a mask, and were instructed to make a saccade to the face as quickly as possible. When non-faces were paired with hallucinated faces, observers had a significant bias to choose the hallucinated face. In pairings with real faces, hallucinated faces were wrongfully chosen significantly more often than non-faces (ie hallucinated faces were more e_ective distractors). These data suggest that human face detection recruits features comparable to the Viola–Jones algorithm, namely localized, oriented broadband luminance transitions.

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m

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Facial expressions and emotional anticipation

T Jellema, L Palumbo (Dept of Psychology, University of Hull, UK; e-mail: L.Palumbo@2007.hull.ac.uk)

Emotional facial expressions are immediate indicators of a_ective dispositions. We investigated to what extent judgments of others' dynamic emotional facial expressions are influenced by (1) emotional anticipation, ie the involuntary anticipation of the other's emotional state of mind, and by (2) low-level perceptual mechanisms such as extrapolation of curves. We presented 770 ms long video-clips of eight di_erent agents showing a 100% happy (or 100% angry) expression that gradually decreased in intensity. We used a 3×2 within-subjects design with as factors the final expression (10% happy vs neutral vs 10% angry) and the perceptual history (happy vs angry). Thirty-two participants rated the final expression on a 5-point scale. The final expression of the happy sequence was consistently judged as slightly angry and the final expression of the angry sequence as slightly happy. This 'overshoot' phenomenon survived the insertion of a 400 ms long mask directly before the final target expression, but was absent when the

final expression was depicted by a di_erent identity. We argue that the bias in perceptual report relies on emotional anticipation, possibly generated by an internal simulation of the observed dynamic facial expression within mirror neuron systems and we speculate that 'embodied simulation' plays a crucial role.

POSTER SESSION: MOTION I

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'Non-retinotopic processing' in Ternus motion displays modelled by spatiotemporal filters
A Pooresmaeili[1], M Cicchini[2], M C Morrone[1,3], D C Burr[2,4] ([1]Scientific Institute Stella Maris, University of Pisa, Italy; [2]Institute of Neurosciences, CNR, Università di Pisa, Italy; [3]Dept of Physiological Sciences, University of Pisa, Italy; [4]Università degli Studi di Firenze, Italy, Università degli Studi di Firenze, Italy; e-mail: arezoo.pooresmaeili@gmail.com)
A recent study (Boi et al, 2009 JOV) has suggested that Ternus stimuli can be a 'litmus test' to di_erentiate between retinotopic and non-retinotopic processing of objects in motion. We adapted their technique to similar stimuli where subjects discriminated the direction of the vertical drift of a grating inside a Ternus stimulus. The vertical drift was produced by sequential presentation of a sinusoidal grating that shifted by a quarter of a cycle at each frame and exchanged its horizontal position with another bar. In such a display, the direction of the vertical drift can be resolved only if information is pooled across space and time. We presented either the two bars alone or together with an extra bar (with no stimulus within it) next to the grating. We found that the addition of the noninformative bar doubled the contrast sensitivity for motion direction discrimination. We modelled these stimuli in 3D (x, y, t) Fourier space and demonstrated that the observed perceptual e_ects can be explained by nonlinear integration of information by a detector that is oriented in space and time, as has previously been suggested to explain other motion illusions (Burr et al, 1986 Proc. Roy. Soc).

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Global flow parsing for roll motion fields
P A Warren, E Balcombe (School of Psychological Sciences, University of Manchester, UK; e-mail: paul.warren@manchester.ac.uk)
The flow parsing hypothesis proposes that recovery of scene-relative object movement is aided by neural mechanisms which discount global retinal motion consistent with observer movement (Rushton and Warren, 2005 Current Biology 15 R542-543;Warren and Rushton, 2009 Current Biology 19 1555-1560). Here, we examine flow parsing in the case of simulated eye/head roll. Stationary observers (N=20) fixated the centre of a CRT showing roll (50 deg/s) optic flow patterns composed of limited lifetime

dots. Two field configurations were used: Full—dots present across the whole display; Quadrant—dots only present in the left and right quadrants. Simultaneously, a probe was presented, moving vertically at one of four positions (–4, –2, 2, 4 deg above the fixation point). After a 2 s stimulus presentation, observers reported the perceived probe motion direction by adjusting the orientation of a virtual paddle. Perceived motion was biased (by 12–14 deg) in the opposite direction to the roll motion. This e_ect was only reduced by around 30% in the quadrant field condition, indicating that it was primarily due to a global discounting process. This result is remarkably consistent with findings from previous studies using radial flow fields and provides further evidence for a global flow parsing mechanism.

m
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Anisotropic facilitation in motion discrimination at low contrast
I Serrano-Pedraza, L Hogg, J C A Read (Institute of Neuroscience, Newcastle University, UK; e-mail: i.s.pedraza@ncl.ac.uk)
Motion direction discrimination is impaired with increasing size of high contrast stimuli. This counterintuitive result has been explained by the center–surround antagonism present in the receptive fields of motion sensors of the visual area MT. However, at very low contrast spatial summation occurs and the direction discrimination improves with increasing size. In this investigation we study the e_ects of stimulus shape and contrast on center–surround antagonism and spatial summation. Using adaptive Bayesian staircases we measured duration thresholds of 5 subjects for vertically oriented Gabor patches of 1 cpd with two types of oval-Gaussian windows, one vertically elongated (S_x=0.35, S_y=1.4 deg) and other horizontally elongated (S_x=1.4, S_y=0.35 deg) moving rightwards or leftwards at a speed of 2 deg/s. We found that at high contrast (92%) duration thresholds were significantly lower for vertically than horizontally elongated windows, as reported previously [Rajimehr, 2005 Journal of Vision 5(8):133]. However, at low contrast (2.8%) we found that duration thresholds were significantly lower for horizontally than vertically elongated windows. We also found no significant di_erences in duration thresholds for vertically elongated windows of di_erent contrast. These asymmetric results in facilitation at low contrast and in suppression at high contrast suggest that the underlying interactions between motion sensors are stronger along the direction of motion.
[Supported by the Medical Research Council and the Royal Society]

m
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Functional characteristics of a motion responsive region in the posterior cingulate cortex compared to V5/MT and MST
E Fischer[1,2], H H Bültho_[1], N K Logothetis[2,3], A Bartels[2,4] ([1]Dept of Human Perception, Cognition and Action, Max Planck Institute for Biological Cybernetics, Tübingen, Germany; [2]Dept of Neurophysiology, Max Planck Institute for Biological Cybernetics, Tübingen, Germany; [3]Div. of Imaging Science and Biomed. Engineering, University of Manchester, UK; [4]Centre of Integrative Neuroscience, University of Tübingen, Germany; e-mail: elvira.fischer@tuebingen.mpg.de)
Motion processing regions apart from V5+/MT+ are still relatively poorly understood. The cingulate sulcus visual area (CSv) in the dorsal posterior cingulate cortex (dPCC) was previously described to respond preferentially to coherent motion and implied in ego-motion processing. We used fMRI to compare responses of CSv/dPCC and of areas V5/MT and MST to distinct types of motion and self-motion cues such as retinal motion and objective motion, determined during pursuit. Both V5/MT and MST had a strong preference for contra- versus ipsi-lateral stimulation, no preference for 2D planar motion versus 3D flow, and reduced yet significant responses to random motion. In contrast, CSv/dPCC preferred 2D planar motion over 3D flow, showed no lateralization, and did not respond to random motion. All areas responded strongly to eye-movement related signals, however CSv responded more to 'real' motion than to retinal motion while the reverse was the case for V5/MT and MST. CSv/dPCC thus di_ers from other motion-responsive regions by its unique preference to full-field, coherent and planar motion cues and its enhanced capability to respond to real motion. These results place CSv/dPCC in a good position to process visual and non-visual cues related to self-induced motion, especially those associated to eye-movements.
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Tuesday
Poster session: Motion I
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The e_ect of walking speed on the sensitivity to curved walking in an immersive virtual environment
C T Neth[1,2], J L Souman[2], H H Bültho_[2], U Kloos[1], B J Mohler[2] ([1]Media and Communication Informatics, Reutlingen University, Germany; [2]Dept of Human Perception, Cognition and Action, Max Planck Institute for Biological Cybernetics, Tübingen, Germany; e-mail: Christian.Neth@tuebingen.mpg.de)
People are relatively insensitive to the curvature of their walking trajectory (Kallie et al, 2007 JEP:HPP 33(1) 183-200). This is exploited in the 'redirected walking' technique which is used in virtual reality to extend the borders of virtual environments (VE) beyond the size of the physical walking area (Steinicke et al, 2009 Journal of Virtual Reality and Broadcasting 6). One method is to slowly rotate the VE while the user is aiming to walk a straight path, inducing him/her to unknowingly walk on a curved trajectory. We tested whether the sensitivity to curvature depends on walking speed. Participants followed a virtual sphere in a VE, which moved on a straight path. During walking, the entire visual scene was rotated, creating a curved real-world trajectory (radius 20–200 m). Walking speed was 0.75, 1.0, or 1.25 m/s. Participants indicated whether their physical walking path curved to the left or right. Discrimination thresholds were estimated by fitting a psychometric function to the proportion of trials in which the trajectory was reported to curve to the left. Curvature thresholds were found to be higher for slow walking. This suggests that the e_ectiveness of the redirected walking technique depends on walking speed.
m
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Optimal motion sensitivity from stochastic adjustment of cell tuning
P Jurica[1], S Gepshtein[2,1], I Tyukin[3], C van Leeuwen[1] ([1]Brain Science Institute, RIKEN, Japan; [2]Vision Center Laboratory, Salk Institute for Biological Studies, USA; [3]Dept of Mathematics, University of Leicester, UK; e-mail: juricap@gmail.com)
Distribution of human sensitivity to motion (Kelly, 1979 JOSA 69 1340–1349) is consistent with the prescription of optimal resource allocation in a visual system with finite number of sensors [Gepshtein et al, 2007 Journal of Vision 7(8):8, 1-18]. Here we show that the optimal allocation can emerge by stochastic adjustment of tuning in motion-sensitive cells. We conjecture that cell tuning to frequency content and speed of stimuli fluctuates such that the size of fluctuations is proportional to reliability of measurements. We find that such fluctuations steer cell tuning toward the distribution predicted by optimal allocation, even though the tuning fluctuations of di_erent cells are independent of one another, and cells receive no feedback about system performance. We examine how di_erent aspects of uncertainty of estimation a_ect the distribution of sensitivity. We find that the emergent distribution of sensitivity approaches that in human vision when the cells tend to preserve their speed tuning more than their spatial and temporal frequency tuning. We also find that changes in statistics of stimulation induce changes in the distribution of sensitivity across the entire range of stimuli, consistent with results of

psychophysical studies of motion adaptation (Gepshtein et al, 2009 Frontiers in Systems Neuroscience doi:10.3389/conf.neuro.06.2009.03.336).
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m
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E_ect of background luminance configuration on illusory motion in peripherally viewed static images
E Tomimatsu, H Ito, S Sunaga (Faculty of Design, Kyushu University, Japan; e-mail: tomimatsu@kyudai.jp)
Fraser and Wilcox (1979 Nature 281 565-566) found that a static image consisting of sectors painted in gradation from black to white generated illusory motion in peripheral vision. Kitaoka and Ashida (2003 VISION 15 261-262) also reported that strong illusory motion was acquired through a stimulus configuration consisting of four segmented luminance steps: black, dark-gray, white and light-gray. We created two types of stimulus rings (FW and KA stimuli) corresponding to the stimuli noted above in simplified versions. We tested them with various configurations of black (0 cd/m2) and white (80 cd/m2) backgrounds around the stimulus rings to investigate the e_ect of luminance in the local adjacent background areas. The luminance profiles of the simplified stimuli were composed of four segmented luminance steps of 10, 30, 50, and 70 cd/m2. The duration and direction of the illusory motion perception were measured with button pressing. The results showed that the duration of the illusory motion was longer when the black area was adjacent or close to the FW stimulus. However, the duration in the KA stimulus showed little e_ect of the background luminance configurations.
Poster session: Motion I
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An Impetus Heuristic in the Perception of Causality?
T L Hubbard (Dept of Psychology, Texas Christian University, USA; e-mail: timothyleehubbard@gmail.com)
Displacements in the remembered locations of stimuli in displays based on Michotte's (1963 The Perception of Causality Basic Books, New York) launching e_ect and entraining e_ect were examined. A moving object contacted an initially stationary target, and the target began moving in the same direction. After contacting the target, the mover became stationary (launching trials) or continued moving in the same direction (entraining trials). In launching trials, forward displacement was larger for movers than for targets; in entraining trials, forward displacement was larger for targets than for movers. Also, forward displacement was larger for targets in entraining trials than for targets in launching trials. The data are not consistent with the hypothesis that decreases in forward displacement of launched targets result from the presence of two objects and a single continuous motion (cf. Choi and Scholl, 2006 Acta Psychologica 123 91-111). The data are consistent with the hypotheses that (a) motion of a launched target is attributed to an impetus imparted from the mover that dissipates with target motion, and (b) introspective perception of physical causality in the launching e_ect results because behavior of movers and targets is consistent with that predicted by an impetus heuristic.

m
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The time-course of motion streak integration at photopic and scotopic light levels
D Alais1, D Apthorp1, A Karmann2, J R Cass3 (1School of Psychology, University of Sydney, Australia; 2Institute for Psychology, Universität Regensburg, Germany; 3School of Psychology, University of Western Sydney, Australia; e-mail: davida@psych.usyd.edu.au)
Temporal integration in the visual system causes fast-moving objects to leave oriented 'streaks' in their wake which could be used to facilitate motion direction perception (Geisler, 1999 Nature). Temporal integration is thought to occur over 100 ms, although this has never been tested for motion streaks. Here we use fast 'streaky' motion to mask briefly-flashed gratings either parallel or orthogonal to the motion. Gratings were presented at various asynchronies relative to motion onset to reveal the time-course of the accruing streaks. Four subjects viewed 500 ms displays of drifting Gaussian dot arrays which moved either fast (13 deg/s) or slow (1.6 deg/s). Fast, parallel motion caused greater masking than fast orthogonal or slow conditions, and masking strength increased over a period of 120 ms. Interestingly, the stronger masking by fast parallel motion was evident 20ms before mask onset, indicating an e_ect of backward masking by motion streaks. We repeated the experiment under scotopic conditions. We found considerably less masking overall but it occurred over a longer period, consistent with claims that scotopic vision uses longer temporal integration. Also, the stronger masking for fast parallel motion relative to the other conditions was reduced, supporting claims that 'form' processing is less e_cient in dim lighting conditions.

m
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Suppression of optic flow sensitivity during locomotion
N Shirai1, S Ichihara2 (1Dept of Psychology, Niigata University, Japan; 2Dept of Psychology,

Tokyo Metropolitan University, Japan; e-mail: nobu.shirai@gmail.com)
Radial optic flow is an important cue for perceiving and controlling ego motion in the three dimensional environment. The radial optic flow sensitivity during locomotion was tested by several psychophysical experiments with an experimental system mainly composed of a wheel chair and a personal computer. The results indicated that the optic flow sensitivity was significantly lower in the condition that the visual and vestibular sensory inputs were congruent for the ego-motion direction than in the condition that the visuo-vestibular inputs were incongruent: for instance, detection sensitivity to a radial expansion pattern was lower when the observer move forward than backward. These results suggest that the optic flow sensitivity is suppressed during locomotion when the relation of the visual and vestibular sensory inputs is in the natural state. Moreover, even when the presented radial flows do not represent the observers' own motion-in-depth (eg De Bruyn and Orban, 1990 Perception 19 21-27), suppression of optic flow sensitivity was observed. This implies that the suppression of optic flow sensitivity stems from relatively lower visual motion mechanisms which process radial structures of flow patterns—rather than the higher mechanisms related—to extract the perception of motion-in-depth events from retinal motion patterns.
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Visual evoked reactions to colour change of a moving bar
C Murd[1,2], K Kreegipuu[1], N Kuldkepp[1], M Tamm[1], J Allik[1] ([1]Institute of Psychology, University of Tartu, Estonia; [2]Institute of Public Law, University of Tartu, Estonia;
e-mail: Carolina.Murd@ut.ee)
In a previous study [Kreegipuu et al, 2006 Vision Research 46(11) 1848-1855] we showed that when an object is moving fast it takes less time to detect the colour change of that object. The purpose of this study was to test whether the e_ect of motion reveals already on the cortical level of information processing. Therefore, we used same task and asked 7 participants to indicate the detection of the colour change of the moving (4.4 and 17.6°/s) or stationary bar—and simultaneously registered EEG. Psychophysical results replicate the findings from the previous study showing that the faster the speed of the moving stimulus the shorter the reaction times to the colour change of the same stimulus. Visual evoked potentials also show dependency on velocity of stimulus changing colour. These e_ects reveal in less positive wave for the colour change of faster moving object compared to a stationary or slower moving object. ERP curves representing the colour change of the faster bar were generally flatter presumably reflecting attention and expectancy.
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Computations mediating global speed perception in human vision
F Rocchi, T Ledgeway, B S Webb (Visual Neuroscience Group, School of Psychology, University of Nottingham, UK; e-mail: lpxfr@nottingham.ac.uk)
The combination of local motion vectors enables the brain to construct a global percept of image motion. This 'pooling' process involves not only the integration of direction signals but also the integration of speeds to drive a coherent motion percept. The mechanisms underlying the ability of human observers to extract global speed are still undetermined; although previous work claims that discrimination performance may involve averaging local speed information (Watamaniuk and Duchon, 1992 Vision Research 32 931-941). Using a two-alternative, forced choice speed discrimination task, we measured the perceived global speed (point of subjective equality) of random-dot-kinematograms (RDKs). Di_erent types of probability distributions governed the speed of RDKs, enabling us to tease apart the motion statistics which best characterized observers' perceived global speed. Our results corroborate previous work showing that the visual system is able to integrate local speed information across space and time to encode global motion. However, the underlying pooling process appears not to be based on a simple averaging strategy as the previous literature suggested, but rather is readily captured by the median of a speed distribution, a robust estimator with the distinct advantage of being much less susceptible to outliers in moving images.
[This work was funding by a Wellcome Trust Research Career Development Fellowship awarded to BSW]
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How sensitive is the visual system to di_erences in mean speed?
B Z Genova, N B Bocheva (Institute of Neurobiology, Bulgarian Academy of Sciences (BAS), Bulgaria; e-mail: bi.genova@dir.bg)
We examined the sensitivity of the visual system to di_erences in the mean speed of motion. The e_ect of the speed range and magnitude on the pooling of local velocity estimates was evaluated. The stimuli consisted of bandpass dots whose speeds were drawn from a uniform distribution. To avoid adaptation e_ects the direction of dot motion changed upwards or downwards in random order. The observer discriminated which of two sequentially presented stimuli, standard and test, moved faster. We found

Weber ratios of 15–20% depending on the speed of the standard. A tendency for larger Weber ratios was observed when the test stimulus was slower than the standard. The speed range has no e_ect on the discrimination performance when the minimal and the maximal stimulus speed deviate by less than 50% from the standard speed. The results are discussed in relation to di_erent population coding schemes for velocity estimation.
[Supported by Grant TK01/200-2009 of the National Science Fund, Bulgaria]

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Factors a_ecting perceptual stability during smooth pursuit eye movements

A Boer, J A Perrone (Psychology Dept, University of Waikato, New Zealand;
e-mail: sasuna@xtra.co.nz)

Smooth pursuit eye movements alter retinal motion but the visual system is somehow able to compensate for the added eye motion. The eye movement compensation is traditionally assumed to consist of a combination of the retinal motion signal and an extra-retinal estimate of eye velocity (Von Holst and Mittelstaedt, 1950 Naturwissenschaften 37 464-476). This view has been expanded upon recently with

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a model that tries to explain the compensation in terms of neural-based vector subtraction [Perrone and Krauzlis, 2008 JoV 8(14):24, 1-14]. However, it is not well known how closely and under what conditions human estimates of image motion follow the laws of vector algebra during smooth pursuit. We therefore tested perceptual performance using a range of pursuit target and stimulus dot velocities. We also varied the stimulus background (moving single dot and moving and static random dot fields). Participants made separate estimates of the stimulus dot direction and speed using a line matching task for direction and magnitude estimation for speed. Preliminary results show that the perceived stimulus dot motion is well predicted by a vector subtraction mechanism in most conditions but when there is weak retinal and visual stimulation, the participants' estimates tend to follow the retinal motion direction.
[Supported by the Marsden Fund Council, administered by the Royal Society of New Zealand]

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Binocular advantage on percept of continuous motion

M Ishii, K Yokoyama (Graduate School of Science and Engineering, University of Toyama, Japan;
e-mail: ishii@eng.u-toyama.ac.jp)

In several psychophysical functions, thresholds may be lower when the test is performed binocularly than when performed monocularly.We evaluated binocular advantage on continuous motion perception at and above threshold. Firstly, motion thresholds were determined under monocular and binocular conditions. Stimuli were briefly-presented Gabor patches with translation of a sinusoidal carrier on near periphery. Subjects observed the stimuli using a mirror stereoscope in a dark room. The apparent contrasts of stimuli were equivalent between monocular and binocular conditions. The observer's task was to decide if the stimulus moved rightward or leftward. We found a binocular advantage of approximately 1.5. Secondly, binocular advantage on motion perception at suprathreshold levels was determined by measuring point of subjective equality (PSE) between monocular and binocular conditions. Monocular condition was the reference and binocular one was the test. Gabor patches mentioned above were presented on the stereoscope. They were presented in succession in random order. The observer's task was to decide if the second stimulus was faster or slower than the first. We found a binocular influence of approximately 1.2 at three times the speed of the motion threshold, but no influence at ten times the speed of the threshold.
[Supported by CREST, Japan]

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Age-related changes in direction motion discrimination using equivalent noise paradigm

M D Stefanova, N B Bocheva (Institute of Neurobiology, Bulgarian Academy of Sciences (BAS),
Bulgaria; e-mail: mirad_st@abv.bg)

We investigated how age a_ects motion direction discrimination. The equivalent noise paradigm was used to separate the contribution of local and global direction information in motion processing. Two age groups—older (mean age 74 years) and younger (mean age 20 years) participated in the experiments. The subject's task was to discriminate the mean direction of motion from vertical. The motion direction of each dot in the stimuli was taken from a normal distribution of di_erent spread that determined the level of external noise. The e_ect of dot number, speed and its variability, type of randomness in direction—constant or changing on every frame—was evaluated. The results show that for both groups the sensitivity to motion direction is lowest for slow or variable speed. The older adults have higher discrimination thresholds in all experimental conditions except for the fastest speed. The results suggest that while aging increases the internal noise in visual motion discrimination, this e_ect is contra-balanced by compensatory processes in conditions of high ecological significance.
[Supported by Grant TK01/200-2009 of the National Science Fund, Bulgaria]

POSTER SESSION: NATURAL IMAGES

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Stereopsis reduces contrast masking in natural images
S G Wardle[1], J R Cass[2], D Alais[1] ([1]School of Psychology, University of Sydney, Australia;
[2]School of Psychology, University of Western Sydney, Australia;
e-mail: swardle@psych.usyd.edu.au)
Binocular disparity between a Gabor probe and broadband Gaussian noise mask breaks contrast masking (Moraglia and Schneider, 1992 Vision Research 32 375-385). We extend this to natural images and demonstrate that stereopsis facilitates both detection and discrimination of a target. Experiment 1 measured contrast detection thresholds in a temporal 2IFC task for a phase-randomised broadband probe at −7, 0, 7 arcmin relative to a natural image mask at zero disparity. Probe detection thresholds were elevated (relative to probe alone) in all conditions and were greatest when probe and mask had the same

disparity (0 arcmin). Experiment 2 controlled for vergence eye movements using nonius lines and kept the probe at zero disparity while varying the mask in depth and confirmed maximal threshold elevation when probe and mask had the same disparity. Experiment 3 measured orientation discrimination of a Gabor probe (±10° from vertical) in a single interval. Discrimination was better when the mask was at a di_erent depth than the probe, suggesting improved detection of disparate targets (Experiments 1 and 2) was not due to the simple presence of a stereo cue in the target interval. Together the results indicate that depth information from stereopsis reduces contrast masking in natural images.

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Visual discomfort and spatial frequency
L O'Hare, P B Hibbard (School of Psychology, University of St Andrews, UK;
e-mail: lo26@st-andrews.ac.uk)
Visual discomfort is associated with a range of conditions, including visual stress, dyslexia, migraine and photosensitive epilepsy. The degree of visual discomfort induced by a pattern is a_ected by its second-order statistical properties. For example, images containing an unusually high concentration of amplitude around a spatial frequency of 3 cpd have been associated with ratings of discomfort (Wilkins et al, 1984 Brain 107 989-1017). Fernandez and Wilkins (2008 Perception 37 1098-1113) manipulated the amplitude spectrum of images, and found that increasing the contrast amplitude around 3 cpd increased ratings of discomfort. Although stimuli were matched for physical contrast, the manipulations could have a_ected perceived contrast, which in turn might account for the rated discomfort. We performed contrast matching experiments and showed that adding excess energy at 3 cpd to 1/f filtered noise stimuli a_ects apparent contrast. When stimuli were then matched for apparent rather than physical contrast, a concentration of energy around 3cpd was still associated with greater ratings of discomfort. These results suggest a special status of these midrange spatial frequencies for visual discomfort, which cannot be accounted for simply in terms of their e_ect on apparent contrast.
[Funded by BBSRC]

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The Birmingham Object Lighting Database: a stereoscopic database of objects, faces, surfaces and outdoor scenes captured under characterised lighting conditions
A J Schofield, C Cleaver, X Jiang (School of Psychology, University of Birmingham, UK;
e-mail: a.j.schofield@bham.ac.uk)
We present an image database containing photographs of objects, surfaces, faces and outdoor scenes. The images were captured as stereoscopic pairs using two Sony DSC-R1 digital cameras and are available in AdobeRGB and linear formats. Surfaces include sinewaves, random undulations, and combinations of bumps and concavities, and were subject to a number of surface treatments including a matt gray finish (from which ground truth illumination can be derived), rough textures, painted textures, coloured stripes, textured stripes, and mixed textured and coloured stripes. In all there were a total of 10 surface profiles each with 7 treatments. The same surface treatments were applied to a sphere and a cube. In addition we photographed miscellaneous objects in their natural state and painted grey. Objects and surfaces were photographed inside a 1 m diameter integrating sphere which produced di_use lighting. To this we added one of 56 spot lights creating 113 di_erent lighting conditions (1 di_use only, 56 di_use plus spot, 56 spot only). We also provide images of 86 faces in profile (16 lighting conditions) and frontal (31 lighting conditions) views. Finally we provide images of 99 outdoor scenes featuring textures and shadows captured under recorded illumination conditions. The database will be accessible at www.bold.bham.ac.uk.
[Funded by EPSRC grant EP/F026269/1]

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Gaze-contingent contrast sensitivity on natural movies
M Dorr, P Bex (Schepens Eye Research Institute, Dept of Ophthalmology, Harvard Medical

School, USA; e-mail: michael.dorr@schepens.harvard.edu)
We investigate contrast sensitivity under natural viewing conditions, ie free viewing of dynamic natural scenes. We developed a gaze-contingent display, based on a spatiotemporal Laplacian pyramid, that decomposes a movie into its frequency bands in real time. Subjects viewed a Hollywood movie while their eyes were tracked at 250 Hz. Every 2 s, energy in the 2-4 cpf band was increased for 600 ms in a 2×2 deg patch at one out of four locations 2 deg away from the point of regard (Condition 1). In Condition 2, energy in this band was set to zero throughout the whole movie (so that no adaptation or masking occured). In Condition 3, energy was also set to zero in the neighbouring bands (1–8 cpd). Even though the target location was bound to the fovea (retinotopic), its perceived location appeared to be bound to the image (geotopic), producing 20% error rates even at clearly visible contrasts. Results show

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that contrast sensitivity was significantly reduced by free viewing natural conditions, by adaptation and masking (with a tuning of about one octave), and when either the eyes or the image moved. In conclusion, natural vision is poorly characterized by conventional, synthetic stimuli and tasks.
[Supported by NIH EY018664 and EY019281]

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Natural scenes statistics account for human cones ratios
O Penacchio, C A Parraga, M Vanrell (Computer Vision Center, Computer Science Dept, Universitat Autònoma de Barcelona, Spain; e-mail: openacchio@gmail.com)
An underlying principle of visual science is that the characteristics of visual systems are determined by evolution to facilitate survival in the environments where these visual systems function. In particular, the number and peak wavelength of the cone photoreceptors in the retina seem to be the product of natural selection [Mollon, 1989 J. Exp. Biol 146 21-38; Párraga et al, 2002 Curr. Biol 12(6) 483-487]. In this work, we explored whether the dissimilarities of densities between the three types of colour photoreceptors, in particular the low density of short wavelength cones, are due to the statistics of natural scenes. We built a colour image representation which allowed us to model and parameterize di_erent cone densities. We then determined the spatial distribution of the parameters which provide power spectrum values near to the ideal one, ie −1, to which processing in the human visual pathway is optimised [Field, 1987 JOSA 4(12) 2379-2394; Atick and Redlich, 1992 Neural Comp 4 196-210; Párraga et al, 2002 Curr. Biol 12(6) 483-487]. We found a high correlation between this distribution and the cone ratio distribution observed in the human population. Our results show that cone ratios are optimally suited to provide the best value of Fourier amplitude spectrum for natural image statistics.

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Size perception from the texture of satellite image of the earth
T Bando, Y Sasaki (Dept of Intelligent Information Engineering and Sciences, Doshisha University, Japan; e-mail: tbando@mail.doshisha.ac.jp)
As natural landscape contain a lot of textures, texture could be one of useful features for size perception of natural scenery. In order to know the role of texture for size perception we investigate how we judge size of the image from natural images without any distinct object that will be measure of size. We prepared 24 satellite images of the earth with various kinds of natural texture from various altitudes and made an experiment to estimate image size. Thirty subjects participated in the evaluation experiment and the results showed us texture is an important feature of size perception. Some feature quantity of texture image like local fractal dimension seems to be play an important role in size perception

POSTER SESSION: OBJECTS AND SCENES

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Persistent FEF activity during object-based working memory
K L Clark, B Noudoost, T Moore (Neurobiology Dept, Stanford University, USA; e-mail: klsy@stanford.edu)
We examine delay period activity in the FEF during the performance of an object-based working memory task. In the task, the monkey is briefly presented a single image (sample) in the periphery. Following the sample presentation, the monkey must remember the sample throughout a 1-second blank delay period. Following the delay, one target (a repeat of the sample image) and one distractor object appear in the periphery and the monkey must saccade to the matching target to receive a reward. We compare FEF neuronal activity during blocks in which target and distractor images always appear at locations that include the sample location (overlapping condition) with blocks in which the target/distractor always appear at positions rotated 90 degrees from the sample position (orthogonal condition). Thus we can examine the degree to which spatially selective delay period activity of FEF neurons contributes to object-based working memory. We also use a memory-guided saccade task to identify the functional classes of FEF neurons that might contribute to the persistence of purely object-based information. We observe persistent, spatially selective delay period activity in the FEF consistent with the use of spatial signals in maintaining object information.

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Poster session: Objects and scenes
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Analytic and holistic object representations in adolescence
M Jüttner[1], E Wakui[2], S Kaur[1], D Petters[1], J Davido_[2] ([1]Psychology, School of Life & Health Sciences, Aston University, UK; [2]Dept of Psychology, Goldsmiths College, University of London, UK; e-mail: m.juttner@aston.ac.uk)
Our previous research has shown surprising limitations in children's recognition of shape changes in animals and artefacts (Jüttner et al, 2009 Perception 38 ECVP Supplement, 165). The present study assesses these findings within the context of Hummel's hybrid theory of object recognition (Hummel, 2001 Visual Cognition 8 489-517). According to this theory recognition of attended objects is mediated by a part-based (analytic) representation together with a view-based (holistic) representation, whereas ignored images are recognized in a strictly view-dependent fashion. This dual account has been shown to correctly predict patterns of visual priming as a function of translation, scale (Stankiewicz and Hummel, 2002), left–right reflection, plane rotation (Stankiewicz et al, 1998) and configural distortions (Thoma et al, 2004) in adult observers. Here we examine these e_ects of visual attention on object recognition in schoolchildren, and discuss implications for the developmental trajectory of dual object representations during adolescence.
[Supported by the Economic & Social Research Council, UK]
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Event-related potentials reveal an early advantage for luminance contours in the processing of objects
J Martinovic[1], J Mordal[2], S M Wuerger[2] ([1]School of Psychology, University of Aberdeen, UK; [2]School of Psychology, University of Liverpool, UK; e-mail: j.martinovic@abdn.ac.uk)
The speed of object recognition is driven by luminance information. Do event-related potentials (ERPs) reflect this luminance superiority? We measured ERPs in response to line drawings of meaningful objects and nonsense objects. Contours were defined along three directions in cardinal colour space: (1) S-cone-isolating (S), or (2) intermediate isoluminant direction (S and L-M), or (3) a full colour stimulus, containing an additional achromatic component (S; L-M; L+M+S) that provided a luminance signal. Stimuli along di_erent colour directions were equated in terms of discrimination thresholds (objects/non-objects). The ERP waveform elicited by the stimuli was characterised by a prominent central parieto-occipital N1 component, peaking around 180–200 ms. N1 amplitude showed objectspecific e_ects for full colour stimuli with an achromatic component. Objects defined by both chromatic and achromatic information were also identified faster and with greater accuracy. As N1 is a marker of visual discriminative processing, we conclude that high-level discrimination starts early and exhibits object-selective e_ects if luminance information is provided, consistent with the superiority of luminance information in object recognition.
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Stimulus determinants of 'change blindness'
O-A Mikhaylova[1], A-N Gusev[2], I-S Utochkin[3] ([1]Laboratory of Psychogenetics, Psychology Institute of Russian Academy of Education, Russia; [2]Psychology department, subdepartment of Psychology of Person, Moscow State University, Russia; [3]Psychology department subdepartment of Physiology, Higher School of Economics, Russia; e-mail: sidney_mail@mail.ru)
Our paper focuses on methodological aspects of studies in the field of 'change blindness'—a failure to notice significant changes in objects located in the visual field due to interruption of perception. Our study investigates the role of some stimulus factors which may influence the observer's ability to perform change detection task rapidly and correctly. Some basic components of change detection have been mentioned by Simons & Levin (1997) and Rensink (1996). However their results are contradictory. Several parameters of visual stimulation varied the chronometric experiments: number of objects (set size), their order in the stimulus space (perceptual organization), the objects shapes, inclusion of a new object that draws attention, and change type—occurrence/disappearance, shift, color, and shape change. Our experiments revealed significant correlations between several factors and search time in change blindness paradigm: number of objects (set size) and their order in the stimulus field. Color appeared to be the change type most di_cult to detect. The results of our study allow the creation of more complex stimulus patterns in studying change blindness and to verify a wider range of hypotheses about the internal mechanisms of change detection, such as spatial attention.
Poster session: Objects and scenes
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Environmental reference frame alters the perceived orientation of three-dimensional object
R Niimi, K Watanabe (RCAST, University of Tokyo, Japan;
e-mail: niimi@fennel.rcast.u-tokyo.ac.jp)
Determining object orientation (eg, front, oblique, or profile) is one of the essential aspects of visual perception. In the daily life, however, objects are often embedded in a complex visual environment. How is the orientation perception of a visual object a_ected by the environmental reference frame? We conducted psychophysical experiments in which observers evaluated the depth-orientation of common objects that were presented within various environmental reference frames (eg sidewalk scene). The detailed analyses of the bias in perceived orientation showed two factors: (1) When the environment was slightly (about 9 deg) misaligned with the object orientation, the evaluated object orientation was assimilated to the orientation of the environment compared to the control condition in which they were aligned. Further, (2) when the environment was slightly (about 9 deg) misaligned with the gaze direction, the observer-centered reference frame (ie, the line of straight ahead) was assimilated to the environment and the evaluated object orientation was biased accordingly. These findings suggest environmental reference frame confounds the perception of object orientation in either observer-centered or object-centered coordinates when the discrepancy between reference frames is not large.

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Implicit classification reveals priority of processing physical properties in novices but processing of higher cognitive properties in experts
M F Imhof, M Straif, C W Stein, C-C Carbon (Dept of Psychology, University of Bamberg, Germany; e-mail: mike.imhof@uni-bamberg.de)
The visual classification of objects is based on properties like physical qualities (eg curvature complexity, color, size) or higher-level qualities (eg artistic style/artist of artworks, or brand/designer of consumer products, respectively). In the domain of art, it was shown that experts base their visual classifications more on style than on content (motif). Typically such results stem from explicit classification studies which might be problematic as we gain no insight of cognitive processes classifying visual stimuli. We employed an implicit classification task with asking for similarity: We let open on what dimensions participants (N=35) base their classifications. As stimuli we used car exteriors ranging fifty years of western car production which varied on two dimensions corresponding to a dimension for physical qualities (curvature) and higher-level qualities (car brand). Participants had to assess indirectly the similarity between all stimuli by positioning them on a checker-board with coordinates. Afterwards participants were tested on their knowledge about design and interest. While novices based their visual classifications primarily on curvature, a clear physical property, experts almost exclusively used both dimensions with particular stress on brands when curvature did not di_er too much. This indicates di_erent strategies and processes of visual classification in novices and experts.

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Retrieval-induced competition between object shape and colour properties
I Reppa (Wales Institute for Cognitive Neuroscience, Swansea University, UK;
e-mail: i.reppa@swansea.ac.uk)
Retrieving a memory, ie of an object, amongst related memories requires setting aside related but unwanted information that competes with the desired memory. Competition for retrieval can arise when the desired items and the unwanted items share the same category (both are fruit names), or the same feature (both are red or both are square). Such competition for retrieval may be resolved through the forgetting of unwanted but related information—retrieval-induced forgetting (Anderson et al, 1994). Here we examined and compared di_erent object properties (shape and colour) in their capacity to elicit competition during memory retrieval for objects. Participants learned novel (Experiment 1) and everyday objects (Experiment 2) and practiced selective retrieval of some of them, before, in the final test, were tested in their memory for all learnt objects. In Experiment 1 memory for unpracticed novel objects that shared the same shape as the practiced objects was poorer than for objects that shared the same colour as the practiced objects. In Experiment 2 memory for unpracticed everyday objects was equally poor when they shared shape and when they shared colour. The findings relate to the role of colour in memory for objects and to theoretical accounts for retrieval-induced forgetting.
[Supported by The Leverhulme Trust]

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Prefrontal hemodynamic activation while watching interesting and uninteresting pictures/scenes
H Kojima[1], R Kaneko[2] ([1]Faculty of Human Sciences, Kanazawa University, Japan; [2]School of Letters, Kanazawa University, Japan; e-mail: hkojima@kenroku.kanazawa-u.ac.jp)
Perception of visual scene depends on observer's attention, interests, preference, thoughts, feeling etc. Such self-referential functions are known to be processed in prefrontal cortex [Jenkins et al, 2008 PNAS

105(11) 4507-4512]. We measured hemodynamic changes around prefrontal cortex and compared when observers watched pictures with/without attention and interests/preference. Method: Stimuli comprised sets of various kinds of photographs, eg landscapes, flowers, buildings etc. Each sets consisted of twenty photographs from only one category. Observers watched the set of photo-slides presented every one second, and asked afterward if they wanted to see them more or not. The response indicated their interests/preference to the pictures/scenes, by which measured data were summarized. Attention was also controlled with two conditions; in control condition, observers just watched the stimuli and then answered their interests/preference, whereas in attention condition, they were asked to find one out-of-group picture among them, if any, and then answered. All twenty participants run ten sets of measurement. The oxyhemoglobin concentration change around prefrontal region was monitored during the stimulus observation by a near infrared spectroscopy (Optical-topography: Hitachi, ETG-4000). Results: The oxyhemoglobin concentration significantly increased in Attention condition. The hemodynamic change also increased when observers reported being indi_erent to the photographs.

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The visual light field in the in- and outside

S C Pont[1], A J van Doorn[1], H de Ridder[1], J J Koenderink[2] ([1]_-lab, Industrial Design Engineering, Delft University of Technology, The Netherlands; [2]_-lab, Electrical Engineering, Mathematics & Computer Science, Delft University of Technology, The Netherlands; e-mail: s.c.pont@tudelft.nl)

Human observers are quite sensitive to various parameters of the (physical) light field in the sense that they are able to adjust the lighting of a gauge object at some arbitrary location such that it 'fits the scene' (Koenderink et al, 2007 Perception 36 1595-1610). Thus the 'visual light field' is defined even in the 'empty space' between objects. In the former paper, we used a matte white sphere as a gauge object, matte white objects on a matte grey background, and stereoscopic presentations. We measured the direction, di_useness, and intensity of the light field. In this experiment we investigate the visual light field in natural scenes, inside buildings and outside in urban and rural settings, with the same experimental paradigm as in the former paper. Using calibrated stereoscopic images, we can correlate the observations with the physical 'ground truth'. We compared settings for natural scenes with and without the addition of matte white objects. We also tested whether observers are able to conduct this task monocularly, using a tripod in the scene to represent the gauge object position. We found that observers generally adjusted the probe close to 'ground truth' under all conditions, even for single still images without matte white reference objects.

[This work was supported by the Netherlands Organization for Scientific Research (NWO)]

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How global is nonselective processing of scenes?

K K Evans, J M Wolfe (Visual Attention Lab, Brigham and Women's Hospital, Harvard Medical School, USA; e-mail: kevans@search.bwh.harvard.edu)

Research has shown that processing of scenes is di_erent from the processing of single objects. Observers can report on nonselective properties (eg gist, global structure and statistical regularities) of scenes within a very short time. Last year we presented results showing that, under demanding, brief (20 ms) exposure conditions, categories interfere destructively when two task-relevant properties are present in the same stimulus. Observers can detect beaches in masked 20 ms flashes, but not if animals (relevant on other trials) are present. This year, we show this collision of categories in saccades made to stimuli that remain visible until response. On each trial observers saw a pair of images and were asked to rapidly saccade to the image that contained a pre-cued target category (eg beach). Targets were always present. Critically on two-thirds of the trials an un-cued task-relevant category was also present (eg animal). It was in the same field on half of those trials and in the other field otherwise. The un-cued category slowed response in decreased accuracy regardless of its position in the display. The collision of categories is not limited to very briefly presented stimuli. Moreover, categories can collide across visual hemifields.

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Poster session: Objects and scenes

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Boundary extension e_ect during long-term isolation and repeated testing

J Lukavsky, R Sikl, M Simecek (Institute of Psychology, Academy of Sciences of the Czech Republic, Czech Republic; e-mail: lukavsky@praha.psu.cas.cz)

Boundary extension (BE) is the tendency to remember scenes as if they included information beyond the boundaries (Intraub and Richardson, 1989 Journal of Experimental Psychology: Learning, Memory and Cognition 15 179-187). We measured the changes in BE e_ect during isolation experiment (105 day space-flight simulation in Mars-500 project). During the isolation the participants were limited only to the interiors of the simulation module. The participants (N=6 in isolation group, N=12 in control group) were shown 48 picture pairs of natural scenes with close-up/wide (CW) conditions balanced and they rated the second picture on 5-point scale (close-up, same, further away). Both groups were tested 4 times

during 3 months interval. In both groups usual BE-specific patterns were observed during the Test 1. In the end of isolation we found the di_erences in CW condition: in control group the BE e_ect was still present but significantly smaller compared to the original e_ect in Test 1, but in the isolation group the BE e_ect persisted. We found no e_ect of scene depth (distant vs near objects; based on participants' ratings).
[Supported by Czech Science Foundation grant (P407/10/P607)]

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The contributions of foveal versus extrafoveal vision to visual search in real-world scenes: Evidence from eye movements

A Nuthmann (Psychology Dept, University of Edinburgh, UK; e-mail: Antje.Nuthmann@ed.ac.uk)

What is more important when searching for an object in a real-world scene: foveal vision or extrafoveal vision? This question was assessed in an object search experiment where gaze-contingent display changes created artificial foveal and extrafoveal scotomas. In a 2×3 design, the type of scotoma (foveal vs extrafoveal) was crossed with three di_erent window sizes (radii: 1.6, 2.9, and 4.1 deg). Gaze-centered scotomas were created on the fly by blending the original colored scene photograph and a blurred version of it into each other via a spatial Gaussian weight mask. Overall, search times were longer when the scene outside the gaze-centered aperture was blurred (extrafoveal scotoma) than when the information inside the aperture was blurred (foveal scotoma). There was an additional e_ect of window size as search times increased (foveal scotoma) or decreased (extrafoveal scotoma) with increasing window size. Based on the eye-movement records, these overall di_erences could be related to particular sub-processes of search. Compared to the control condition, participants made longer or shorter saccades when searching the scene with a foveal or extrafoveal scotoma, respectively. It is concluded that extrafoveal vision is more important than foveal vision during object search in natural scenes, due to the importance of saccade target selection.

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How text attracts attention during real-world scene viewing

H C Wang, M Pomplun (Dept of Computer Science, University of Massachusetts, Boston, USA; e-mail: hchengwang@gmail.com)

The present study investigated (1) whether text objects attract visual attention more strongly than nontext objects and (2) what visual features of text objects a_ect the allocation of attention. We selected text and non-text objects in the eye-movement database compiled by Judd et al. (2009 IEEE International Conference on Computer Vision (ICCV)), in which real-world scene stimuli were presented to subjects for three seconds in a free viewing task. The LabelMe [Russell and Torralba, 2008 International Journal of Computer Vision 1(3), 77, 157-173] database was used to localize and classify text and non-text objects. The results suggest that text objects have a shorter first-acquisition time, higher fixation-landing probability, and shorter minimum fixation distance than non-text objects. Remarkably, this advantage is virtually non-existent for text objects below a certain size, even when the text is still clearly readable. Besides the finding of greater text objects attracting attention more strongly, a temporal eye-movement analysis also revealed that this advantage lasts longer with greater eccentricity of objects. Regarding the visual features of objects, we found that luminance contrast of objects influences minimum fixation distance for both text and non-text objects, but saliency (Itti and Koch, 2000 Vision Research 40 1489-1506) only a_ects non-text objects but not text objects.

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Horizon estimation: Perceptual and computational experiments

C Herdtweck[1], C Wallraven[1,2] ([1]Human Perception, Cognition and Action, Max Planck Institute for Biological Cybernetics, Germany; [2]Dept of Brain and Cognitive Engineering, Korea University, Seoul, South Korea; e-mail: christian.herdtweck@tuebingen.mpg.de)

The human visual system is able to extract a vast amount of scene information from a briefly shown picture. Here, we investigated the ability to accurately and quickly estimate horizon position, which is related to viewer orientation and scene structure in general. In the first, perceptual study, we asked 18 participants to estimate the horizon position after a 150 ms, masked presentation of typical outdoor scenes from di_erent scene categories. All images were shown in upright, blurred, inverted, and cropped conditions to investigate the influence of di_erent information types on the perceptual decision. Overall, participants were fairly consistent in their estimates ($r=0.62$); inverted images, however, produced significantly worse estimates, indicating the importance of global scene consistency. In the second, computational experiment, we correlated the performance of several algorithms for horizon estimation with the human data—algorithms ranged from simple estimations of bright-dark-transitions to more sophisticated frequency spectrum analyses motivated by previous computational modeling of scene classification results. Correlations between human and computational estimates ranged from 0.2 to 0.6 and varied by algorithm and scene category. Overall, frequency spectrum analysis provided

the best results, which taken together with the perceptual data, highlights the importance of global, frequency-based information in scene processing.
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The role of various categories of changes in the inducement of change blindness
M Porubanova, R Sikl (Institute of Psychology, Academy of Sciences of the Czech Republic, Czech Republic; e-mail: misel99@gmail.com)
Change blindness is extreme di_culty in detecting changes in a visual field that is induced once a brief blank is interjected in between two alternating images. The study aimed at exploring the e_ect of di_erent categories of changes on the inducement of change blindness. Following categories of changes were presented: probability/improbability, figure/background, centrality/marginality, and relevance/irrelevance. In the study we used the flicker method, which consists in two alternating images being separated by a brief blank field while measuring the reaction time until the change is detected. We found that changes that were probable, central, relevant and within figure are detected more easily in comparison with changes improbable, marginal, irrelevant and occurring within background ($p<0.01$). Surprisingly, in terms of the category figure-background, the most di_cult to notice were changes occurring within close proximity to the figure, but being part of the background. This indicates that when searching for changes in a visual field, parts of the scenes close to the most powerful attractors are being shadowed, and therefore seem to be ignored by selective attention. This could be ascribed to the role of expectation in the change detection task.
[The study is a part of Research project AV0Z70250504]
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The inconsistency advantage in visual change detection is inconsistent
S Spotorno[1,2], S Oddera[1], F Bracco[1], S Faure[2] ([1]Dipartimento di Scienze Antropologiche, University of Genoa, Italy; [2]Laboratoire de Psychologie Cognitive et Sociale, University of Nice - Sophia Antipolis, France; e-mail: spotorno@nous.unige.it)
Previous studies showed a change detection advantage for objects which violate scene gist, implying that they attract attention earlier and more e_ciently than their consistent counterpart, with a higher probability of being quickly represented. We hypothesize that this finding is due to a bias: studies compared highly improbable objects with consistent but non-necessary (nondiagnostic) objects, having a mean probability of occurrence. In a one-shot change detection task with 32 participants, we presented briefly (120 ms) realistic drawings in which an object was added or deleted. Changes to highly inconsistent objects were compared with those to highly consistent (diagnostic) objects, whose presence or absence determined a gist modification. Changes were of high or low perceptual salience. Detection was faster and more accurate for highly salient changes. No inconsistency advantage was found. Conversely, there was an accuracy advantage for diagnostic objects only in cases of deletion, suggesting a priority in early scene representation. These results indicate that data in the literature may be fictitious and might also suggest better attentional capture and memory encoding for the most predictable objects. What seems crucial for such processes, however, is the object's importance for the sense initially attributed to the scene, ie a strong contribution, or the lack of it.
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TALK SESSION: 3D VISION, DEPTH
m Binocular matching by adaptive correlation
M Vidal-Naquet[1], S Gepshtein[2,1] ([1]Brain Science Institute, RIKEN, Japan; [2]Vision Center Laboratory, Salk Institute for Biological Studies, USA; e-mail: michel@brain.riken.jp)
Binocular matching is modeled by computing correlation between parts of retinal images. The correlation is high when image patches are identical to one another, ie, when binocular disparity is uniform across visual direction. But in the natural environment disparity varies across visual direction because surfaces are generally slanted or curved, making the corresponding patches dissimilar. We show how visual systems can overcome this di_culty by 'flexible' matching, taking advantage of positionally invariant mechanisms such as complex cells (Riesenhuber and Poggio, 1999 Nature Neuroscience 2 1019-1025). In flexible matching, parts of matching templates move relative to one another so they detect similar patches under warping transformations of images produced by projection of slanted surfaces (Mikolajczyk and Schmid, 2005 IEEE Transactions on Pattern Analysis and Machine Intelligence 27 1615-1630). We show that di_erent degrees of matching flexibility are optimal for di_erent surface slants, allowing visual systems to adaptively tune themselves: to di_erent slants in di_erent parts of the scene, and to slants common in the stimulation. Our results agree with results of psychophysical studies which showed that perception of slanted surfaces cannot be explained by the standard models that use rigid correlation [Allenmark and Read, 2009 Journal of Vision 9(8):262].
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m The role of pictorial cues in the hollow-face illusion: Binocular disparity versus motion parallax

T V Papathomas[1,2], M Marks[3], S M Silverstein[4], B P Keane[1,4], P Sinha[5], V Pavlovic[6] ([1]Lab of Vision Research, Center for Cognitive Science, Rutgers Unversity, USA; [2]Dept of Biomedical Engineering, Rutgers Unversity, USA; [3]Dept of Psychology, University of Maryland, USA; [4]Division of Schizophrenia Research, UMDNJ-Robert Wood Johnson Medical School, USA; [5]Dept of Brain and Cognitive Sciences, MIT, USA; [6]Dept of Computer Science, Rutgers Unversity, USA; e-mail: papathom@rci.rutgers.edu)

Purpose: This study had two goals: (1) Examine the role of pictorial cues in the illusion. (2) Compare the strength of bottom-up signals (binocular disparity, motion parallax) in countering the illusion. Methods: Goal 1—Used four variations of a hollow mask: (a) random-dot textured; (b) uniformsurface; (c) realistically painted shadowless; (d) realistically painted shadowed (illusion-congruent). Goal 2—Used two viewing conditions: Stationary binocular. Moving monocular; motion amplitude equal to interpupillary distance. Veridical perception was measured by recording the predominance of perceiving the concave stimulus. Results (13 observers): Binocular viewing—Ranking of stimuli in eliciting the veridical percept, in descending order: (a), (b), (c), (d). Monocular viewing—Stimulus (a) elicited the strongest veridical percept; the rest were about equal. Binocular viewing elicited stronger veridical percepts than monocular viewing for each stimulus. Conclusions: The random-texture dots in stimulus (a) served as depth markers that provided signals for 3D shape recovery and the absence of features prevented top-down processes to exert strong influences. Binocular viewing—Ranking of stimuli in eliciting the veridical percept was as expected. Monocular viewing—The absence of any di_erences among stimuli (b), (c), (d) is hard to explain. As expected, binocular disparity proved to be a stronger data-driven cue than motion parallax.

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m The role of visual and extraretinal information in disambiguating motion parallax transformations: a test of Nawrot's (2003) pursuit eye movement hypothesis

B J Rogers (Dept of Experimental Psychology, University of Oxford, UK; e-mail: bjr@psy.ox.ac.uk)

Motion parallax transformations, whether created by observer or object movement, are best understood as the consequence of the rotation of a 3D object relative to the observer (Rogers and Gyani, 2010 Perception 39 330-348). How then is it possible to distinguish between rotations that are a consequence of head (or object) translation and those due to concomitant object rotation? Using Patrick Hughes's 'Reverspective' artworks, our previous work has shown that binocular disparities and static perspective

information both constrain the interpretation of parallax transformations. The present study compared the role of dynamic perspective changes and extramarital information (Nawrot, 2003 Vision Research 43 1553-1562) in disambiguating the sign of motion parallax depth. We used electronic versions of 'Reverspectives' in which the direction and extent of observer-produced parallax and the presence of both static and dynamic perspective information were independently manipulated. The results show that there is no default assumption of object stationarity and that the sign and magnitude of perceived depth are a consequence of the particular combination of di_erent sources of 3D information. Even when motion parallax is the only source of 3D information, the 'disambiguating' role of pursuit eye movement signals can be overridden by the dynamic perspective changes that signal object rotation.

m The importance of a visual horizon for distance judgments under severely degraded vision

W B Thompson[1], K Rand[2], M Tarampi[2], S H Creem-Regehr[2] ([1]School of Computing, University of Utah, USA; [2]Dept of Psychology, University of Utah, USA; e-mail: thompson@cs.utah.edu)

To understand the e_ect of low vision on mobility, we need to know how low vision a_ects the ability to judge the locations of objects in the environment. Distance judgments under simulated severely degraded vision are surprisingly accurate, as indicated by blindfolded walking to previously viewed targets [Tarampi et al, 2010 Attention, Perception, & Psychophysics 72(1) 23-27]. The current study investigates the role of visual context in these judgments. Normally sighted individuals, wearing goggles that severely reduced acuity and contrast, viewed targets through a viewing box that restricted the field of view to occlude information provided by the sidewalls and ceiling. In one condition, the context in which participants viewed target objects was manipulated such that the perceived intersection of the floor and back wall appeared raised, increasing the angle of declination to the target relative to the apparent floor-wall intersection. Results suggest individuals in the raised intersection condition show decreases in distance estimates in blindfolded walking relative to control participants, supporting an account that reliance on the visually-defined horizon contributes to the ability to accurately judge distance to objects appearing only as indistinct blobs. A follow-on study is being conducted to see if the results generalize to blindfolded throwing to previously viewed targets.

[Supported by NIH grant EY017835]

m The relationship between accommodation and vergence responses, and visual fatigue in stereoscopic displays

K J MacKenzie, S J Watt (School of Psychology, Bangor University, UK;

e-mail: pss802@bangor.ac.uk)
Conventional stereoscopic displays present images at a single focal plane (the screen). The resulting conflict between the stimuli to vergence and accommodation has been shown to cause visual fatigue [Ho_man et al, 2008 Journal of Vision 8(3):33, 1-30]. Here we examine the relationship between the amount of visual fatigue induced and the ability to decouple accommodation and vergence responses. Using a novel multiple-focal-plane display, we measured vergence and accommodation responses in untrained observers when (i) the stimuli to accommodation and vergence were consistent (realworld conditions), and (ii) they were in conflict (conventional-display conditions). We measured visual fatigue throughout the experiment. We found large individual di_erences in the ability to decouple accommodation and vergence responses. Some observers were able to accommodate and converge accurately to the cue-conflict stimuli, while others showed significant convergence-driven accommodation. Overall, observers reported more fatigue in the cue-conflict condition than in the cuesconsistent condition. However, the extent to which observers were able to decouple their accommodation and vergence responses was a poor predictor of visual fatigue. We conclude that in untrained observers, accommodation-vergence conflicts induce significant visual fatigue, not only in individuals who cannot decouple their accommodation and vergence responses, but also in those who can.
[Supported by the EPSRC]

m Perception of nonrigid 3D shapes from motion cues

Q Zaidi, A Jain (Graduate Center for Vision Research, SUNY College of Optometry, USA;
e-mail: qz@sunyopt.edu)
Many organisms and objects deform nonrigidly when moving, requiring perceivers to distinguish shape changes from object motions. However, almost all structure-from-motion models use rigidity assumptions, and the abilities of observers to correctly infer nonrigid 3D shapes from motion cues have not been measured empirically. We asked observers to judge whether the cross-sections of rigid and nonrigid 3D cylinders were deeper/shallower than circular, using only motion cues for pointSymposium: The complexity of visual stability
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light shapes. Cylinders were rotated simultaneously around the vertical and depth axes. Experiment 1 used fixed elliptical cross-section cylinders that were either rigid or flexing in the depth or friendlily plane. Perceived depth was slightly less than veridical. Nonrigid cylinders were judged as deeper, but sensitivities estimated from slopes of psychometric curves were similar for rigid and nonrigid cylinders. Experiment 2 added dynamic inflation and deflation to all cylinders. Thresholds for detecting inflation/deflation were similar for rigid and nonrigid cylinders. Interestingly, complex rotation of symmetric cylinders led to asymmetric percepts that corresponded to asymmetric velocity profiles (Experiment 3). A shape-from-motion factorization model, using trajectory basis functions, explained the results, as did a simpler motion-perspective model (perceived depth inversely proportional to local velocity). Consequently, observers do not need rigidity assumptions to extract 3D shapes from motion cues.
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m Perceived object stability is a_ected by the internal representation of gravity

R W Fleming[1], M Barnett-Cowan[1], H H Bültho_[1,2] ([1]Dept of Human Perception, Cognition and Action, Max Planck Institute for Biological Cybernetics, Tübingen, Germany; [2]Dept of Brain and Cognitive Engineering, Korea University, South Korea;
e-mail: roland.fleming@tuebingen.mpg.de)
Knowing an object's physical stability a_ects our expectations about its behaviour and our interactions with it. Objects topple over when the gravity-projected centre-of-mass (COM) lies outside the support area. The critical angle (CA) is the orientation for which an object is perceived to be equally likely to topple over or right itself, which is influenced by global shape information about an object's COM and its orientation relative to gravity. When observers lie on their sides, the perceived direction of gravity is tilted towards the body. Here we test the hypothesis that the CA of falling objects is a_ected by this internal representation of gravity. Observers sat upright or lay left- or right-side-down, and observed images of objects with di_erent 3D mass distributions that were placed close to the right edge of a table in various orientations. Observers indicated whether the objects were more likely to fall back onto or o_ the table. The subjective visual vertical was also tested as a measure of perceived gravity. Our results show the CA increases when lying right-side-down and decreases when left-side-down relative to an upright posture, consistent with estimating the stability of rightward falling objects as relative to perceived and not physical gravity.
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m When do infants use a convexity assumption to interpret a 'line drawing' and perceive spatial layout?

A Yonas, S Corrow, J Mathison (Institute of Child Development, University of Minnesota, USA;
e-mail: yonas@umn.edu)
When line drawings are presented on paper, we experience a weak sense of 3D layout, but if the pictorial surface is eliminated and the wire display is viewed monocularly, a vivid experience of depth can

occur. To examine the use of a convexity assumption by infants, a real wire half-cube, with its vertex pointed away from the participant was presented to 5- and 7-month-old infants (N=25 and 22). The direction of reaching was scored under monocular and binocular conditions. Infants reached to the illusory convex corner at the center of the display more often in the monocular than in the binocular condition, $F_{1,45}=42.4$, $p<0.01$. These results suggest that the infants use a convexity assumption to perceive a concave cube as convex under monocular viewing, while binocular cues specify the real concave shape. The convexity assumption overcomes linear perspective and motion parallax information for depth. In a related study we found that infants perceive a concave face as convex under monocular presentation. For the convexity assumption to be activated, infants do not require the presentation of a familiar object such as a face. Further work with preferential looking will be used to investigate the use of a convexity assumption in younger infants who do not yet reach.
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SYMPOSIUM: THE COMPLEXITY OF VISUAL STABILITY

m Temporal uncertainty and the localization of flashes that are presented around the time of saccades

F Maij, E Brenner, J B J Smeets (Human Movement Sciences, Vrije Universiteit Amsterdam, The Netherlands; e-mail: f.maij@fbw.vu.nl)

Visual objects that are flashed around the time of a saccade are often mislocalized. This perisaccadic mislocalization consists of a shift in the direction of the saccade and a compression towards the saccade target. In order to be able to localize flashes that are presented around the time of a saccade, we not only need to know where we perceived the image of the flash on the retina, but we also need to know when the retina was stimulated relative to time of the saccade. We made a simple model to explain the pattern of perisaccadic mislocalization. This model only consists of the following: a normally distributed temporal uncertainty about the time of the flash, a saccadic eye movement and a spatial prior (to perceive things where one is looking). We combine the temporal uncertainty with the saccadic eye movement to obtain a likelihood for the position of the flash. By combining this likelihood with the spatial prior, we can explain both the compression and the shift. Here, we show how experimentally changing the temporal uncertainty of the flash influences the mislocalization pattern.

m Visual-spatial determinants of saccadic suppression

H Deubel[1], B Bridgeman[2] ([1]Dept of Psychology, Ludwig-Maximilians-University München, Germany; [2]Dept of Psychology, University of California, Santa Cruz, USA; e-mail: deubel@psy.uni-muenchen.de)

Changes of stimulus location or form are often not perceived if they occur during saccadic eye movements. This type of saccadic suppression is considered to be a major factor for the maintenance of visual stability across eye movements. To investigate the various components that a_ect perceived constancy, we measured displacement detection for a wide range of saccade directions and a wide range of target jump directions relative to the saccades. Jumps were more easily detected in directions orthogonal to saccades than in co-linear directions, and jumps were more easily detected in the saccade's direction than in the opposite direction. A signal detection analysis showed these e_ects to be di_erences in sensitivity, not bias. Displacement thresholds were unrelated to either saccade directions or postsaccadic fixation errors. By comparing trials with and without corrective saccades, we show that triggering a corrective saccade does not contribute to displacement detectability. Introducing a brief postsaccadic stimulus blanking however increased detectability under all conditions. The findings demonstrate that both spatial and visual components of the postsaccadic stimulus determine perceptual constancy.

m Behavioural evidence for the remapping of saccade target locations

M Rolfs[1,2], D Jonikaitis[3], H Deubel[3], P Cavanagh[2] ([1]Dept of Psychology, New York University, USA; [2]Laboratoire Psychologie de la Perception, Université Paris-Descartes, France; [3]Dept of Psychology, Ludwig-Maximilians-University München, Germany; e-mail: martin.rolfs@gmail.com)

The fate of visual information following each eye movement has been the subject of intense study. The initial notion the retinal images from each fixation are fused to build a stable representation of space in world coordinates has been convincingly ruled out (eg, O'Regan and Lévy-Schoen, 1983 Vision Research 23 765-768). Similarly, low-level adjustments of feature sensitivity that might occur in a spatiotopic reference frame could not be supported (Knapen et al, 2010 Journal of Vision 10(1):8, 1-13). However, the visual system can deal predictively with the consequences of saccades on the locations of targets, keeping track of targets as the eyes move. This predictive process takes into account not only the expected displacement to the saccade goal, but also much of the landing site error of these eye movements [Collins et al, 2009 Journal of Vision 9(5):29, 1-9]. We suggest that these predictive processes are the basis of our ability to keep track of objects across saccades and present a new line of research showing that spatial foci of attention selecting the targets of our eye movements are updated in a retinal frame of reference, every time we make a saccade. Our results support the notion that a representation of the outside world is not necessary to achieve visual stability.

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m Role of extraretinal monitoring signals in the perceptual integration of space across eye movements

F Ostendorf, C J Ploner (Dept of Neurology, Charité - Universitätsmedizin Berlin, Germany; e-mail: florian.ostendorf@charite.de)

We continuously move our eyes when we inspect a visual scene. Although this leads to a rapid succession of discontinuous and fragmented retinal snapshots, we perceive the world as stable and coherent. Probing visual stability under laboratory conditions, however, draws a di_erent picture: Briefly flashed stimuli undergo systematic mislocalization when presented in a critical time window across saccade onset (perisaccadic mislocalization). Moreover, human subjects frequently fail to detect visual displacements that happen within a saccadic eye movement (saccadic suppression of displacement). We recently investigated the role of extraretinal monitoring in transsaccadic space integration by exploiting the phenomenon of saccadic suppression of displacement. Data are presented from a recent case study in a patient with a lesion a_ecting transthalamic monitoring pathways and from healthy human subjects in which we disturbed the transsaccadic integration of monitoring signals with transcranial magnetic stimulation (TMS) over a cortical target structure, the frontal eye fields (FEF). Our findings suggest that the brain draws on internal monitoring signals for the transsaccadic integration of visual space whenever no stable visual rea_erent information is available after a saccadic eye movement. Visual stability across saccades may be achieved by a flexible and adaptive combination of extraretinal und visual rea_erent signals.

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m Eye position signals in the primate visual system

B Krekelberg[1], A Morris[1], K Schreiber[1], M Kubischik[2], K-P Ho_mann[2], F Bremmer[3] ([1]Center for Molecular and Behavioral Neuroscience, Rutgers University, USA; [2]Neurobiology, Ruhr University Bochum, Germany; [3]DeptNeurophysics, Philipps-University Marburg, Germany; e-mail: bart@rutgers.edu)

Information on where the eye is pointing is almost as important as the light that enters the eye. Eye position information is needed to allocate attention, to program a reach , and to attain visual stability. Consistent with this, eye position encoding has been found in many areas of the monkey brain. We investigated whether such signals exist in the human brain and demonstrate their presence in many areas of the human brain, and its dorsal part in particular. These data suggest that the lessons learned about the role of eye position signals in the monkey brain are quite relevant to understanding the human brain. Eye position signals must not only be veridical during fixation, but also updated rapidly around eye movements. We investigated this using single-cell recordings in posterior parietal areas of the macaque. We find that a modest number of cells su_ce to provide a high fidelity population eye position signal during fixation. Second, this signal is rapidly updated around eye movements, such that a veridical signal is available in the typical interval between two saccades. Finally, these eye position signals anticipate the actual eye movement and, when combined with a veridical retinal input, predict the often described perisaccadic mislocalization. This suggests that these signals are not only available and useful, but that they are indeed used by the visual system.

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m Space representation across fast eye movements

F Bremmer[1], M Kubischik[2], K-P Ho_mann[2], B Krekelberg[3] ([1]DeptNeurophysics, Philipps-University Marburg, Germany; [2]Dept Neurobiology, Ruhr-University Bochum, Germany; [3]Center for Molecular and Behavioral Neuroscience, Rutgers University, USA; e-mail: frank.bremmer@physik.uni-marburg.de)

Eye-movements challenge visual processing. Several studies have shown that spatial processing during voluntary eye-movements is not veridical. In a series of psychophysical studies in humans we investigated whether such a mislocalization can also be observed during reflexive eye-movements, ie optokineticnystagmus (OKN) and afternystagmus (OKAN). Our results clearly show that spatial perception during OKN and OKAN is not veridical. Interestingly, a direct comparison showed substantial di_erences for localization during both eye-movements. In a second set of experiments we investigated the neuronal processes underlying the representation of spatial information during visually guided saccades by recording single cell activity from behaving monkeys. Recordings were performed in visual cortical areas MT, MST, LIP, and VIP. Stimulus responses in most neurons in areas MT and MST were

suppressed, but in all cases the visual RF was eye-centered. VIP activity was also often suppressed, but the spatial reference-frame of the responses was sometimes not eye-centered. Responsiveness of LIP neurons was in many cases dominated by performance of the saccade itself. At the population level, the responsive region in area LIP was enlarged perisaccadically with a maximum width at the time of

saccade-onset. This magnification of the responsive region could account for the behaviorally observed perisaccadic mislocalization.
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SYMPOSIUM: PSYCHOPHYSICS: YESTERDAY, TODAY, AND TOMORROW

m Spatial vision

G Westheimer (Westheimer Laboratory, University of California, USA;
e-mail: gwestheimer@berkeley.edu)

Fechner's proposal of relating the physical and mental worlds has nowhere been realized better than in spatial vision. Stimulus specifications are derived from dimensions of physics and concepts of geometry; the methodology yielding data on mental states is as rigorous as elsewhere in science. Those studying the concerned neural substrate could do no better than take over the toolkit of human psychophysics. Fechner's prescience, and the current successful implementation of his vision, should however not dissuade us from the inquiry whether it constitutes the most appropriate approach to an understanding of the rules according to which we perceive space, spatial relationships and object form.

m Temporal dynamics of object vision

B Breitmeyer (Visual Cognition Lab, Dept of Psychology, University of Houston, Texas, USA;
e-mail: brunob@uh.edu)

The psychophysics of the temporal properties of visual object processing and perception has taken several significant turns in the last four decades. Among these were especially recent developments in the study of (spatio)temporal vision in relation to such phenomena as masking, motion, feature transposition and object updating. These have been informed by concomitant rethinking driven by new developments and emphases in our understanding of the massive interconnectedness of the cortical functional architecture. Included among these developments are the existence of -range oscillations within neural circuits, feedforward/feedback and bottom-up/top-down interactions, and accounts of conscious and pre-/nonconscious object vision that distinguish between temporal properties of contour and surface processing. The psychophysics of the temporal properties of preconscious and conscious object processing continues be a rich source of phenomena that inform ongoing advances in the application of brain imaging studies to our understanding of object vision.

m Colour Vision 1990–2010

J D Mollon (Dept of Experimental Psychology, Cambridge University, UK;
e-mail: jm123@cam.ac.uk)

Two decades ago, chromatic information was thought to be carried wholly by the parvocellular channel of the visual system, and the late R. Rodieck was pilloried for his suggestion, in 1990, that chromatic information is carried by bistratified ganglion cells. At that time, however, colour scientists were already troubled by the discrepancy between the two axes of our phenomenological colour space and the two channels identified by electrophysiological recording from the retina and lateral geniculate nucleus. Perhaps colour vision is unusual, but the most influential developments in the last two decades have been at the retinal level—we have learnt about the amino acids that control the spectral sensitivities of the opsins, about the spatial arrangement of the receptor arrays, and—perhaps most importantly—about the several distinct types of ganglion cells that carry chromatic information. Also notable has been the extensive research on chromatic signals in the natural world, their role in the evolution of colour vision, and their recognition in varying contexts. But some of the glorious old questions remain to exercise us: Should the phenomenally pure or 'unique' hues enjoy a special status in colour science and should we be looking for their origin in the retina, or in cortical physiology, or in the external world? Is chromatic discrimination enhanced at the boundaries of colour categories? Is colour contrast a consequence of the normal mechanism of colour constancy?

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m Motion perception psychophysics: Yesterday, Today, Tomorrow

G Sperling (Dept of Cognitive Sciences, University of California, USA; e-mail: sperling@uci.edu)

A selective review of the motion psychophysics in the last 50 years that has led to computational motion theories in three areas: insect psychophysics, elementary human motion processes, and higher-level motion perception. Modern psychophysical motion theory begins with the 1960 publication in English of Reichardt's correlation model for motion perception in the beetle. Remarkable improvements in instrumentation now allow excellent flight recordings of fruit fly (Drosophila melanogaster) responses to motion stimuli. In elementary human motion psychophysics, the use of sinewave stimuli to measure the spatial and temporal properties of motion perception was critical. The understanding of what a motion system consists of was greatly aided by single-unit recordings in monkey area MT; this was followed by the division of human motion perception into first-, second-, and third-order motion systems. The application of the three-systems psychophysics to drosophila shows it has all three. Among the higher level motion phenomena, the reformulation of kinetic depth e_ect as structure from motion (sfm) and the understanding of how sfm and heading direction can be computed from motion flow fields have been areas of major progress. However, there are still no accepted models of speed perception, plaid motion

(two sinewaves), nor sfm.

m Suprathreshold contrast perception and features

M J Morgan (Max Planck Institute of Neurology, Germany; e-mail: m.morgan@city.ac.uk)

This review is concerned primarily with psychophysical and physiological evidence relevant to the question of the existence of spatial features or spatial primitives in suprathreshold human luminance contrast vision. The emphasis will be on the experimental and computational methods that have been used for revealing features, rather than on a detailed comparison between di_erent models of feature extraction. Color and texture fall largely outside the scope of the review, though the principles may be similar to those of luminance. Similarities between di_erent psychophysically-based model will be emphasized rather than minor di_erences. All the models considered in the review are based on the extraction of directional spatial derivatives of the luminance profile, typically the first and second, but in one case the third order, and all have some form of nonlinearity, be it rectification or thresholding.

POSTER SESSION: ART AND VISION

m1

That's typical! Isn't it? About the microgenesis of art perception as a function of expertise

K Neuhauser[1], C-C Carbon[2] ([1]Faculty of Psychology, University of Vienna, Austria; [2]Dept of Psychology, University of Bamberg, Germany; e-mail: kathi_neuhauser@gmx.at)

Visual categorization is a basic function in organisms. Its point of reference are prototypes (ie 'best examples'), whose importance is indisputable for everyday life. However, in art perception little attention has been paid to prototypicality. Therefore, a microgenetic experiment (PT: 10, 30, 50, 70 ms) using cubistic and surrealistic paintings was conducted to examine the relevance of prototypicality in consideration of expertise, which is of particular importance in categorization. The following main hypotheses were investigated: Paintings with prototypical depictured content are preferred and judged faster by novices, whereas pictures with prototypical style are favored and quicker rated by experts. While the non-experts showed a marginal increase of liking with prototypicality of content and a significant increase when content as well as style was prototypical, the experts did not show any preference for prototypicality. With expertise, prototypicality lost its e_ect on preference. Concerning the microgenesis of preference it was found that both dimensions of prototypicality are already relevant for categorization, even at 10 ms, and gain in relevance with increasing presentation time up to 50 ms. Further studies should investigate whether other dimensions of art might influence experts' preferences such as originality, novelty or complexity.

m2

Negative visual aesthetic impression in the lateral orbitofrontal cortex: a neuroimaging study

E Munar, M Nadal, J Rosselló, A Flexas (Human Evolution & Cognition Group (IFISC), University of the Balearic Islands, Spain; e-mail: enric.munar@uib.cat)

Knowledge in neuroaesthetics has considerably increased as a result of neuroimaging studies. Neuroimaging studies have revealed activity in a broad network of brain regions while participants enjoyed the beauty of visual stimuli. Nevertheless, little attention is usually paid to what goes on with regards to the non-beautiful stimulus processing. The objective of this poster is to show the results of brain activity registered by magnetoencepahlography (MEG) when participants judged the visual stimuli

as not beautiful. In a visual aesthetic appreciation task, participants were asked to response whether they found each image beautiful or not beautiful, emphasizing the importance of expressing their own impressions. Activity in right lateral orbitofrontal cortex (RLOFC) was greater while participants rated visual stimuli as not beautiful than when they rated them as beautiful. This activity took place 300 ms after stimulus onset.We suggest that this activity is associated with a negative initial aesthetic impression formation driven by the negative a_ective value of visual stimuli rated as ugly. Other neuroimaging studies have revealed activity in the orbitofrontal cortex (OFC) while participants enjoyed the beauty of images. From our results, we hypothesize a di_erential processing for beautiful and non-beautiful visual stimuli in the OFC.

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m3

The a_ective e_ect of size

H S Kim[1], W M Ahn[2], K H Han[2] ([1]Cognitive Science, Yonsei University, South Korea; [2]Dept of Psychology, Yonsei University, South Korea; e-mail: hyosunkim@gmail.com)

The purpose of this study was to examine whether the size of figures (circle, square) has an impact on participants' a_ect. In study 1, the e_ect of size was examined. The stimuli were physically di_erent-size figures with a same-size frame. Three kinds of size were presented. Participants were twenty-one students, who were asked to rate the scores of the three scales (displeasure–pleasure, sleep–arousal, and static–dynamic) on the seven-point Likert scale. The results of circle and square were analyzed separately. For both circle and square, the result of one-way ANOVA showed that the size was a significant main e_ect on the 'pleasure' and 'dynamic' scales. In study 2, the e_ect of relative size was

examined. The stimuli of relative size were physically a same-size figure with di_erent-size frames, so the ratios of a figure to frames were di_erent. As a result, the a_ective e_ect of relative size was statistically significant on the 'pleasure' scale for both circle and square. These results suggest that the size could influence a person's a_ect regardless of shapes of figures.
[This study has been supported by Yonsei university and Brain Korea 21]

m4

Visual aesthetics: Relevant measures and their dependence on object class
M D Augustin[1], J Wagemans[1], C-C Carbon[2] ([1]Laboratory of Experimental Psychology, University of Leuven (KU Leuven), Belgium; [2]Dept of Psychology, University of Bamberg, Germany; e-mail: MDorothee.Augustin@psy.kuleuven.be)
A central problem in empirical research on art perception and aesthetics is the lack of standardised instruments to assess aesthetic experiences. We aimed to find out which verbal measures might be most useful to assess aesthetic impressions of di_erent kinds of visual materials and to what extent such descriptors di_er between object classes. In a free naming task 178 participants listed words that they would use to describe aesthetic impressions of eight di_erent object classes covering a wide range of materials relevant in visual aesthetics: visual art, faces, cars, geometrical shapes and patterns, buildings, landscapes, interior design and clothing. Beautiful and ugly were among the most frequently mentioned words for each category. In addition, analyses of frequencies and order of mentions revealed clear category-specific patterns. For instance, word usage for faces showed similarities with that for geometrical shapes and patterns, with a high relevance of descriptors of form and symmetry, while the word restful seemed to be specifically relevant to describe the aesthetics of landscapes. The results underline the importance of adequate and specific measures in di_erent domains of visual aesthetics and provide the necessary empirical basis for the development of custom-made standardised questionnaires.

m5

Objective measures for complexity and curvature in visual objects and scenes
M Raab, C-C Carbon (Dept of Psychology, University of Bamberg, Germany; e-mail: marius.raab@uni-bamberg.de)
Complexity and curvature are known to be important variables for predicting preferences for scenes and objects, with eg medium complex and curved exemplars being liked best. Research basing on both measures face two essential problems: (a) the need of subjective ratings, (b) adjusted measures related to the set of stimuli used. Furthermore, despite the relevance of both variables, we do not know on which basis humans evaluate them. We looked for objective measures which converge with subjective data. For complexity we tested several compression algorithms based on typical JPEG algorithms revealing high convergence between physical and psychological complexity measures ($r=0.8$). Curvature was algorithmized by a self-devised cascade of image filtering, vectorization, and statistical analysis of the resulting vector data, using straightforward geometric shapes. We propose a framework relying on such measures to assess preference values for scenes and objects. We argue that high-level semantic

information is predominately determined by basic information processing like retinal edge detection and early vision filtering mechanisms. Using experimental data, we show strengths and weaknesses of these raw data approaches in the domain of aesthetics—showing when semantic image information is more than a mere syntactic composition of elements.

m6

On the search for the Super-Jesus. Which features does a depiction in art history need to be identified as Jesus?
C-C Carbon[1], P Gruber[2], P Sommer[2] ([1]Dept of Psychology, University of Bamberg, Germany; [2]Faculty of Psychology, University of Vienna, Austria; e-mail: ccc@experimental-psychology.de)
Although discrete facial descriptions of Jesus Christ are absent in the bible, free associations with his outward appearance seem to be strong . But are people really able to detect Jesus' face among others, and if yes, what are the distinctive characteristics? We empirically tested this question by employing a detection task (N=65) for a wide range of religious images from the 4th–20th century, frontally depicting Jesus (N=161) and other holinesses (N=155). All images were cleared from external identifying features such as halos. An analysis of the material revealed an extreme variety of di_erent appearances of Jesus: blond to black hair, light blue to black eyes, and faces with ordinary, very special or no beard at all. Jesus depictions from early centuries (5th–9th) were rarely recognized as Jesus, whereas pictures from the late Middle Ages and particularly the late Renaissance were relatively fast and accurately recognized, although detection rates were still only marginally over 70%. It seems that the Renaissance created the typical, ie best detectable and most attractive, image of Jesus: a approximately 30-year-old Caucasian with a larger mouth relative to average Caucasians, a curled full beard and a thin likeness being only 75% of the same-aged average face.

m7

Matching style and content in art perception
G Harsanyi, C-C Carbon (Dept of Psychology, University of Bamberg, Germany; e-mail: geza.harsanyi@uni-bamberg.de)

A major characteristic of representational art is the way how objects are depicted. Augustin et al (2008 Acta Psychologica 128 127–138) reported a dissociation of processing artistic style and depicted content in a microgenetic study based on similarity ratings of simultaneously presented art stimuli. Processing of style came later in action than processing of content, and style gained more relevance as the meaning of content for similarity ratings was kept constant. We extended the study with alternative art stimuli and by employing a new task. By using a simultaneous similarity-decision task, Augustin et al. implicitly asked for a type of processing relying strongly on perceptual cues. To mainly enforce higher cognitive and memory based processing of the artworks, we used a sequential matching task instead. In two experiments art novices judged whether displays of paintings were same or di_erent regarding visual identity (Experiment 1) or regarding the two relevant dimensions (Experiment 2). Pairs of paintings were crossed for 4 styles and 4 contents. Results are in accord with Augustin et al: when content does not provide enough information, style information is recruited to solve the task. This emphasizes that novices' art processing already relies particularly on style information.

m8

Penrose 'darts' and 'kites' on medieval buildings

B Lingelbach[1], N Wade[2] ([1]Lingelbachs Scheune - Optical Phenomena, HTW - Aalen, Germany; [2]School of Psychology, University of Dundee, UK; e-mail: bernd@leinroden.de)

It is well known that Necker-like tilings can be found throughout Europe, especially in Italy but also in Great Britain, Turkey, Spain, Portugal and Germany (Wade et al, 2010 Perception 39 1-4). All these tilings are based on squares, rhombi, parallelograms, hexagons or octagons, but none of the patterns utilise pentagons. Despite the fact that the five-point star is one of the oldest known symbols, pentagons are very rarely used as decorations. There are some on Islamic buildings but apparently they are not used in medieval European architecture. In Sicily, the Monreale Cathedral (late twelfth century) is known for its synthesis of Arabic, Byzantine and Norman styles of architecture and art. In the adjacent cloister, the Islamic influence on architecture and art is clear to see. The cloister garden is famous for its 228 columns which are richly decorated. The arches between the columns are made up of pentagons which are decorated with 'darts' and 'kites' similar to those of the original Penrose tessellation. They do not actually touch each other—there is a small gap between the single elements. Seen from a greater distance these gaps form illusionary contours like saw tooth lines. The twelfth century artists seemed not only to know about the nonperiodic tilings, but they also created illusionary contours.

m9

Processing of style in artworks: A highly complex matter

S J Lö_er[1], C-C Carbon[2] ([1]Faculty of Psychology, University of Vienna, Austria; [2]Dept of Psychology, University of Bamberg, Germany; e-mail: sarahloe_er@hotmail.com)

Recent results concerning the dynamics of perception of representational art suggest that processing of content starts earlier than processing of style (Augustin et al, 2008 Acta Psychologica 128 127-138). It remains unclear whether these results arise from the specific stimuli used or whether the findings that 'style follows content' can be seen as a general principle in art perception. To better control the degree of similarity between di_erent styles, we did not use given artistic material but generated our own artistic-like styles via series of Adobe Photoshop filters trying to imitate six art historic styles. So we were able to relatively change the degree of di_erence between the styles compared with the given di_erence of used contents (faces and cars). The procedure followed a microgenetic account with varying presentation times (10, 30, 50, and 100 ms). By varying the similarity of style while keeping the similarity of content constant, we were able to show that content can also follow style. The results show di_erences in the microgenesis not only of style and content, but also of di_erent styles emphasizing the distinction between style as a mode of depiction and style as a concept.

m
10

The anterior bias in visual art

M Bertamini, K M Bennett, C Bode (School of Psychology, University of Liverpool, UK; e-mail: m.bertamini@liv.ac.uk)

Composition is an important topic in visual art. The literature suggests a bias for objects on the right side (Levy, 1976 Neuropsychologia 14 431-445) and two additional biases with respect to positioning of objects within a rectangular frame: a Centre bias and an Inward bias. Here we have analysed images of animals from three datasets of actual works of art to test the existence of biases in terms of the position of where the animal is placed. Two datasets were from artists well known for their portraits of animals (Bewick, 1753–1828, and Stubbs, 17241806) and the third was a medieval bestiary (Bodleian Library MS764, c.1240). Results from the three datasets (total 357 images) were consistent. There was no overall displacement of the subject to the right or to the left of the picture. However, we found a bias consisting of more space in front compared to behind the animal. Because our animals never face towards the centre we use the term Anterior bias for clarity. In addition, we found a modulation of this bias on the basis of the facing direction of the animal, consisting of a stronger Anterior bias for left facing animals. This asymmetry may originate from a combination of an Anterior bias and a Right bias.

m
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Psychophysics and eye tracking on original and mirrored Rembrandt etches: No evidence for left to right viewing and no preference for mirrored etches
I T Hooge[1], W A van de Grind[2] ([1]Experimental Psychology, Universiteit Utrecht, The Netherlands; [2]Neurobiology, Universiteit Utrecht, The Netherlands; e-mail: i.hooge@uu.nl)
When Rembrandt produced etches he did not compensate for the mirroring due to printing. According to hypotheses of Wöl_in (1941) and Ga_ron (1948): Paintings are read from left to right and therefore mirrored artwork is of less quality. We tested this hypothesis by conducting three experiments with 62 original and mirrored Rembrandt etches. Our pool of observers consisted of 15 naïve and 23 expert observers. Except for 14 experts, observers could not distinguish originals from mirrored images. Only a few of the experts had a preference for either mirrored or original Rembrandt etches, naives did not have any preference. Eye tracking revealed that (1) first fixations were mainly in the centre of the image, (2) both order of fixation, fixation times and number of fixations on specific elements of the images did not di_er between original and mirrored images. Averaged scan paths of mirrored images were mirrored scan paths of original images. Our results lead us to dismiss the Wöl_in–Ga_ron hypothesis.
m
12
The brain's response to assignment of authenticity when viewing artwork
A J Parker[1], M F Huang[1,2], H Bridge[2], M J Kemp[3] ([1]Dept Physiology, Anatomy and Genetics, University of Oxford, UK; [2]FMRIB Centre & Dept Clinical Neurology, University of Oxford, UK; [3]Trinity College, Oxford, UK; e-mail: andrew.parker@dpag.ox.ac.uk)
Neuroscientists often attempt to summarize the multi-faceted experience of viewing art with a single rating of aesthetic impact, a generalization that is mostly rejected by scholars in the art world. Here we focus on a particular aspect of the viewer's experience, namely whether a work of art has been assigned as authentic or derivative, something that is held to make a material alteration to the viewer's perception. We examined the brain's response to assignment of authenticity during the viewing of Rembrandt portraits.Within occipital and temporal regions of the cerebral cortex that are concerned with visual processing, there was remarkably little direct e_ect of assignment. Assignment reliably changed

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the response of fronto-polar cortex, with a bias towards right hemisphere activation in right-handed individuals. Assignment of authenticity also altered responses in the precuneus and orbitofrontal cortex. Interestingly, fronto-polar cortex showed evidence consistent with its exerting a modulatory influence upon visual cortex. The pattern of brain responses indicates that the major e_ects of assignment of authenticity are not directly visual, nor even unitary; rather, changes are observed in the interaction between multiple brain regions that all make relevant contributions to the viewer's experience.
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POSTER SESSION: ATTENTION II
m
13
Suppressing attention to avoid saccades: Evidence for a common modulatory mechanism
S Dhawan, H Deubel, D Jonikaitis (Dept Psychologie, Ludwig-Maximilians-Universität, München, Germany; e-mail: srdhawan@gmail.com)
A dual facility at making or suppressing a response is a prerequisite for behavioral flexibility and is likely to be a vital component of eye movement programming. However, majority of saccade suppression studies focus on suppression of the entire saccadic system rather than an active suppression of a specific eye movement. In this study, we used a peculiar experimental situation presented by the delayed nonmatch to sample task, in which subjects have to suppress making a saccade to a target location but still encode it through a delay period to be able to identify the nonmatch target later. We added a behavioral measure of spatial attention during the delay period and found that encoding a location as forbidden to saccades leads to an attentional cost at that location, as reflected by lower performance in a prioritized perceptual processing task. Our data also indicates an enhancement of spatial attention at locations that were encoded as saccade targets. These results point to a common modulatory signal that can either be enhanced at a given location leading to a positive saccadic response and an enhanced object discrimination ability or be suppressed at a particular location leading to suppression of both saccades and attention.
m
14
Attending to what is relevant! Irrelevant singletons do not capture attention but can produce filtering costs
A A Wykowska, A Schubö (General and Experimental Psychology, Ludwig-Maximilian University Munich, Germany; e-mail: wykowska@psy.uni-muenchen.de)
It has not yet been established whether spatial attention is automatically driven to the most conspicuous items in a given context. Some authors postulate that most salient items capture spatial attention, eg

Hickey, McDonald, & Theeuwes (2006 Journal of Cognitive Neuroscience 18 604-613) whereas others, eg Folk & Remington (2006 Visual Cognition 14 445-465) argue that conspicuous irrelevant items can produce only nonspatial interference.The present ERP studies examined the deployment of attention in visual search displays that contained an additional salient irrelevant singleton. N2pc locked to the search display showed that attention was allocated to the target but not to the irrelevant singleton. As the onset of the target-N2pc was delayed when the irrelevant singleton was presented in the opposite hemifield, the irrelevant singleton presumably produced some (nonspatial) interference.ERPs were also analysed relative to the onset of probe that was presented subsequent to the search display. Probe-locked P1 showed sensory gain for probes located at the target position but not for irrelevant singletons in the additional singleton condition. Taken together, the present data show that irrelevant singletons do not necessarily capture attention but can produce nonspatial filtering costs.
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The e_ect of spatial position on the temporal modulation of task performance

B de Haan[1], C Rorden[2], H-O Karnath[1] ([1]Hertie-Institute for Clinical Brain Research, University of Tübingen, Germany; [2]Dept of Communication Sciences and Disorders, University of South Carolina, USA; e-mail: bianca.de-haan@klinikum.uni-tuebingen.de)

Visual extinction is a common consequence of brain injury, where individuals can report a single stimulus at any location but fail to detect the contralesional item when shown two stimuli. A study of neurological patients by Rorden and colleagues (Rorden et al, 2008 Neuropsychologia 47 321-329) found that extinction is maximal at stimulus simultaneity when the target stimuli straddle the central gaze fixation location, while it is maximal when the ipsilesional stimulus has a temporal lead on the contralesional stimulus when both target stimuli are presented in the ipsilesional visual field. The authors argued that these results are most parsimoniously explained as a consequence of low-level biased competition, but

acknowledged that the popular disengagement model of attention could also accommodate the results. The present study set out to investigate whether these findings could be replicated in neurologically healthy subjects, which could adjudicate between these models. We were able to replicate the findings from Rorden and colleagues in healthy subjects, which suggests that the findings can be explained by a low-level physiological bias due to cortical magnification, thus providing additional support for the view that extinction can be viewed as a consequence of biased competitive interactions.

m

16

Endogenous orienting of attention in the visual field: e_ect of stimulus eccentricity

Y Bao[1,2], Q Lei[1], E Pöppel[2,3] ([1]Dept of Psychology, Peking University, China; [2]Human Science Center, Ludwig Maximilian University Munich, Germany; [3]Institute of Medical Psychology, Ludwig Maximilian University Munich, Germany; e-mail: baoyan@pku.edu.cn)

In a previous study on exogenous orienting of attention (Bao and Pöppel, 2007 Cognitive Processing 8 37-44), Bao and Pöppel demonstrated a functional dissociation of attentional control in the visual field. Specifically, the inhibitory processing as measured by inhibition of return (IOR) e_ect is much stronger at far periphery relative to the central visual field up to 15 degree eccentricities. To further examine whether this eccentricity e_ect also exist in endogenous orienting of attention, we presented an informative arrow cue at the fixation location with 80% probabilities that a subsequent target appeared at the cued location. Two stimulus eccentricities of 9 and 18 degrees were selected to represent the two functional regions as revealed in the previous study. Results showed faster responding to targets appeared at the cued location relative to the uncued opposite location for both stimulus eccentricities. Moreover, this facilitation e_ect was significantly larger at far periphery of 18 degree relative to the 9 degree eccentricities, showing an eccentricity e_ect of facilitation. These results are consistent with the hypothesized functional dissociation of attentional control in the visual field, and suggest a general dissociation in both exogenous and endogenous orienting of attention.
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The role of target-distractor relationships in the guidance of attention

S I Becker[1], C L Folk[2], R W Remington[1] ([1]School of Psychology, University of Queensland, Australia; [2]Dept of Psychology, Villanova University, USA; e-mail: s.becker@psy.uq.edu.au)

Current theories of attention propose that attention is guided by the interplay of (1) a bottom-up saliencybased attentional system and (2) a top-down, feature-specific attentional system. As a consequence, attention is sometimes drawn to regions with high feature contrasts, and sometimes to objects that have the feature values of the search target (eg, red). Here, we demonstrate that the relational properties of the target can be critical for search: If the target di_ers in a single relation from all irrelevant items (as is the case in, eg pop-out search), observers will usually tune attention to the relational properties of the target

(eg, tuning attention to all redder items). The present talk will (a) briefly introduce this new relational vector account (Becker, in press Journal of Experimental Psychology: General), (b) present evidence from multiple studies showing that attention can indeed be genuinely tuned into a particular direction in feature space, and (c) briefly review the explanatory power of this new account. In particular, it will be argued that fusing the relational idea with the contingent capture account allows explaining a wide range of diverse e_ects that have previously been attributed to di_erent attentional systems.

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Object substitution masking of long duration targets—Now you don't see it, now you do

A Gellatly, D Guest, M Pilling (Dept of Psychology, Oxford Brookes University, UK; e-mail: agellatly@brookes.ac.uk)

Object substitution masking (OSM) is when perception of a target object is impaired by a temporally trailing mask object even though the two do not have abutting or overlapping contours. Because the target item is typically presented for 50 ms or less, OSM is explained in terms of early processes involved in perception of new onset objects. In keeping with this presumption, Gellatly et al (in press Journal of Experimental Psychology: Human Perception and Performance) found that if a display of items had been present for 500 ms before the target was indicated, then OSM was very weak or totally absent. They accounted for their finding in terms of the individuation hypothesis (Moore and Lleras, 2005 Journal of Experimental Psychology: Human Perception and Performance 31 1171-1180), according to which OSM occurs if target and mask are assigned a shared token representation; when the target appears markedly earlier than the mask, the two tend to be individuated by being assigned separate tokens. In this paper we report several experiments demonstrating that, after all, OSM can be obtained

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with long duration targets under certain circumstances and we o_er an explanation of when this will and will not be the case.

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Does distractor familiarity impair multiple object tracking?

L O Oksama[1], Y Pinto[2], P D Howe[2], T S Horowitz[2,3] ([1]Dept of Psychology, University of Turku, Finland; [2]Visual Attention Laboratory, Brigham and Women's Hospital, USA; [3]Dept of Ophthalmology, Harvard Medical School, USA; e-mail: lauri.oksama@mil.fi)

We used a multiple object tracking experiment with unique objects to test a prediction of Bundesen's (1990) race model of selective visual attention. In this model, objects compete for entrance into visual short-term memory (VSTM).The first objects to finish processing win the competition. Because more familiar objects are processed more quickly, making distractors more familiar than targets should interfere with tracking by giving the distractors an edge in accessing VSTM. Stimuli were pictures of objects. We manipulated familiarity by either choosing the stimulus set randomly from trial to trial (unfamiliar) or repeating the same set throughout a block (familiar). Distractor and target sets were manipulated independently. In Experiment 1, 12 observers tracked 3 of 8 objects. Target familiarity ($p=0.002$) improved performance, but there was no e_ect of distractor familiarity ($p=0.35$, interaction $p=0.92$). In Experiment 2, 32 observers tracked 4 of 8 objects, with similar results (target familiarity, $p<0.001$, distractor familiarity, $p=0.81$, interaction, $p=0.65$). Target familiarity strongly a_ects performance. However, contrary to the predictions of the race model, distractor familiarity did not impair tracking. We discuss the implications for dynamic visual attention.

m

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Spatial probability aids visual target discrimination

B Anderson[1,2], M Druker[1] ([1]Dept of Psychology, University of Waterloo, Canada; [2]Centre for Theoretical Neuroscience, University of Waterloo, Canada; e-mail: britt@uwaterloo.ca)

Can attentional e_ects be completely explained by a combination of stimulus prior probability, noise, and rewards? As a first step, we investigated if participants would learn to use the statistical properties of visual stimuli in a visual discrimination task. Participants were required to quickly judge the color of a single dot presented on a CRT screen. The probability for where a stimulus would appear was manipulated, but this did not predict the identity of the stimulus or the required response. In Experiment 1, stimuli were more probable in an o_-center area of the computer display. Stimuli in high-probability areas garnered faster responses without accuracy changes. In Experiment 2, stimuli locations were on three concentric circles. RT was modulated by whether stimuli were, or were not, on the high probability annulus. In general, participants were unaware of the probability manipulations. These data suggest that inhomogeneities in spatial probability can be learned by subjects online and aid visual target discrimination. Prior probability seems a parsimonious summary of cue e_ects in attentional tasks. These data are a first step in evaluating whether Bayesian Decision Process components will provide a su_cient account of attentional e_ects in visual search and discrimination tasks.

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Non-retinotopic capture of exogenous attention
M Boi[1], M H Herzog[1], H Ogmen[2,3] ([1]Laboratory of Psychophysics, Brain Mind Institute, École Polytechnique Fédérale de Lausanne (EPFL), Switzerland; [2]Dept of Electrical and Computer Engineering, University of Houston, Texas, USA; [3]Center for Neuro-Engineering and Cognitive Science, University of Houston, Texas, USA; e-mail: marco.boi@epfl.ch)
Capture of exogenous attention is generally believed to be mediated by retinotopic mechanisms. Using a Ternus-Pikler display, we show that attentional capture can occur non-retinotopically. In a first frame, three squares appeared for 200 ms followed by a 70 ms ISI and a second frame containing the same squares shifted by one position. Observers perceived three squares moving as a group. Within the central square of the first frame, a cue was flashed either at the center (neutral cue) or at a peripheral position (retinotopically neutral cue, non-retinotopically 100% valid cue). In the central square of the second frame, a conjunction search display was presented. Subjects had to search for a red tilted bar. In non-retinotopic coordinates, ie relative to the surrounding squares, the valid cue occurred at the same position as the target. Retinotopically, however, neither the neutral nor the valid cue was presented at target position. A retinotopic account of attention predicts no advantage for valid versus neutral cue, as both cues recruit attention at a retinotopic location where the target was not presented. In contrast to this prediction, we found faster reaction times for validly- versus neutrally-cued trials. These results provide strong evidence for a non-retinotopic account of exogenous attention.
[This research was supported by the Pro*Doc 'Processes of Perception' of the SNF]
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Poster session: Attention II
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E_ect of precue durations on shift of attention in real 3-D space
T Kimura[1], T Miura[2], S Doi[3] ([1]Faculty of Health Sciences for Welfare, Kansai University of Welfare Sciences, Japan; [2]Dept of Applied Cognitive Psychology, Osaka University, Japan; [3]Faculty of Engineering, Kagawa University, Japan; e-mail: takimura@fuksi-kagk-u.ac.jp)
Concerning shift of attention, previous studies about attention in real 3D space used relatively longer precue durations as compared to those in virtual stereoscopic 3D space. In this study, the temporal characteristics of attention in real 3D space under observer static and moving forward (0.44 meter per second) conditions were investigated. Short (200 ms) and long (600 ms) precue duration were used. Two near targets and two far targets were arranged around the fixation point. Digits (from one to four) indicating target location were used as precues to examine the e_ect of cue validity. Participants were required to discriminate the shape of the targets. Results showed that in the moving condition, reaction times for shifting attention from far space to near space were faster than the reverse in both precue duration conditions. Furthermore, the di_erence in the reaction times between cued target and uncued target was larger in the long precue duration. These results indicate that there are di_erent temporal characteristics in the shift of attention in depth depending on whether observer is static or moving.
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Episodic feature retrieval: Can it occur with an inhibited object and changing behavioural goals?
Z Chen[1], Y-Y Yeh[2] ([1]Dept of Psychology, University of Canterbury, New Zealand; [2]Dept of Psychology, National Taiwan University, Taiwan; e-mail: zhe.chen@canterbury.ac.nz)
An important function of our visual system is to track objects across space and time. When two objects appear in close spatiotemporal proximity, the visual system must determine whether they belong to two distinct entities or to two di_erent states of the same object. There is considerable evidence that the features of a previously seen object are spontaneously retrieved when it is perceived as a di_erent instantiation of a subsequent object. The present study investigated spontaneous feature retrieval when a previously seen object had been actively inhibited and when participants' behavioural goals changed from trial to trial. In two experiments, participants performed one of two tasks on each trial based on a task cue. The task cue was followed by a single stimulus, whose size determined whether it should be responded to or whether participants should wait for the next stimulus to appear. We manipulated the relationship between the stimuli so that their features either matched or mismatched. We found no evidence of spontaneous feature retrieval regardless of whether the stimuli were likely to be seen as di_erent states of the same object or as di_erent objects.
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Changing patterns of ignoring distractions in the older adult brain
H A Allen, H Payne (School of Psychology, University of Birmingham, UK; e-mail: h.a.allen@bham.ac.uk)
Older adults may be impaired at ignoring irrelevant distractions. We hypothesised that when older adults are able to maintain performance, brain activity (via fMRI) will reveal patterns of compensatory activity.

We compared older (aged 67+) and younger (aged <25) adults ability to ignore irrelevant information using the preview visual search paradigm. In the preview search condition half the distracters (the 'preview', static rotated L's) were presented 2 s before the remaining distracters and target (inverted T). Participants were instructed to ignore these previewed items. Reaction times and brain activity was compared to a baseline condition where everything was presented simultaneously. For participants in both groups, reaction times were faster in the preview condition, indicating successful ignoring of the previewed items. BOLD activity, however, was higher ($p<0.05$ corrected) for older than younger adults in the early visual cortex but higher for younger than older in the superior frontal gyrus. Both groups showed activity in areas such as the cingulate gyrus, precuneus and parietal regions previously implicated in this task. Whilst older adults can exclude irrelevant distractions, they do this despite losses in task control functions. These losses lead to di_erences in function even at lower levels.
[ESRC]

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Arac attack! Natural images of spiders and snakes in a response priming paradigm

A Haberkamp, T Schmidt (Dept of Psychology I, Faculty of Social Sciences, University of Kaiserslautern, Germany; e-mail: haberkamp@sowi.uni-kl.de)

People with spider or snake phobia might process phobia-related images more rapidly than neutral ones. We report a series of experiments to investigate the influence of aversive (spiders and snakes) and non-aversive (flowers and mushrooms) natural pictures on response times in phobic and nonPoster session: Attention II

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phobic participants. In each experimental trial, one prime and target, chosen randomly from one of the four stimulus categories, were presented in rapid sequence, and participants performed speeded keypress responses to classify the targets. Participants performed two classification tasks: They either discriminated spiders and snakes from flowers and mushrooms (animal vs non-animal task) or spiders and mushrooms from snakes and flowers (snake vs spider task). Targets acted as backward masks for preceding primes. Results in non-phobic participants showed strong and reliable priming e_ects in both conditions but larger e_ects in the animal–nonanimal task. We will compare these results with those of phobic participants to disentangle e_ects of image processing speed with those of attentional biases.
[Supported by DFG (German Research Foundation)]

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Two types of preattentive landscape in early vision

O Levashov (Dept of Brain Research, Centre of Neurology Research, Russia;
e-mail: olevashov40@mail.ru)

Previously we found some kind of visual attractors (VA) in early vision (Levashov et al, 2006 Perception 35 ECVP Supplement, 86). VA is a stable local maximum of preattentive landscape (PL) and corresponds to important visual feature. In this report we studied PL at 15 color image of 3D scenes. Each image (St) was exposed at 500, 1000, and 1500 ms successively in 3 trials. Subjects had to indicate the color and digit of the post-St matrix just fixated. It was the shift of eye fixation in 3 successive trials that formed PL. 42 subjects participated (21–65 years old). The size of St was 20×24°. Two types of PL were found:'global' and 'local'. Subjects with global PL fixated all VA on the image and were able to shift their attention from 1st depth plan to horizon and vice versa. In contrast, subjects with local PL were not able to shift their fixation to far objects and fixated VA near initial fixation point. In addition subjects of the latter group missed the VA on the periphery of St.

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The time course of working memory e_ects on visual attention

I C Dombrowe, C N L Olivers, M Donk (Cognitive Psychology, Vrije Universiteit Amsterdam, The Netherlands; e-mail: i.dombrowe@psy.vu.nl)

Previous work has generated inconsistent results with regard to what extent working memory (WM) content guides visual attention. Some studies found e_ects of easy to verbalize stimuli whereas others only found an influence of visual memory content. To resolve this, we compared the time courses of memory-based attentional guidance for di_erent memory types. Participants first memorized a color, which was either easy or di_cult to verbalize. They then looked for an unrelated target in a visual search display and finally completed a memory test. One of the distractors in the search display could have the memorized color. We varied the time between the to-be-remembered color and the search display, as well as the ease with which the colors could be verbalized. We found that the influence of easy to verbalize WM content on visual search decreased with increasing time, whereas the influence of visual WM content was sustained. However, visual working memory e_ects on attention also decreased when the duration of visual encoding was limited by an additional task or when the memory item was presented only briefly. We propose that for working memory e_ects on visual attention to be sustained, a su_ciently strong visual representation is necessary.

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Attention mediates a learned perceptual bias
B T Backus, S G Fuller (Graduate Center for Vision Research, SUNY College of Optometry, USA;
e-mail: bbackus@sunyopt.edu)
Long-lasting perceptual biases for ambiguous rotating stimuli are learnable (Haijiang et al, 2006 PNAS 103 483-488). Does this learning depend on visual attention? Thirteen observers participated in a threeday experiment. An arrow indicated one of four task locations. Two locations were assigned an 'attended rotation direction' (ARD) of clockwise and two were counterclockwise. On test trials (128/session) an ambiguous cube appeared. On training trials (352/session), stereo-disambiguated cubes appeared at all four locations. Attended training stimuli had ARD. Unattended training stimuli had a mixture of ARD and anti-ARD in Experiment 1, or pure anti-ARD in Experiment 2. On Day 3 the ARDs were reversed at all locations (both experiments) to assess long term learning. In Experiment 1, 84% of Test trials agreed with the ARD on Days 1–2. This learned bias did not reverse with reversal training on Day 3, but only dropped to 77%. In Experiment 2, however, 43% of Test trials agreed with ARD on Days 1–2, dropping to 32% on Day 3. These data show that long term bias for 3D rotation can be learned with or without attention, and that during training, one attended trial causes learning similar to 2–3 unattended trials.
[Supported by NIH R01-EY-013988, HFSP RPG 3/2006, and NSF BCS-0810944]

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Electrophysiological evidence for an early locus of interaction between visual attention and working memory
E G Akyurek[1,2], M Leszczynski[2], A Schubö[2] ([1]Experimental Psychology, University of Groningen, The Netherlands; [2]Experimental Psychology, Ludwig Maximilian University Munich, Germany; e-mail: egakyurek@rug.nl)
We investigated the temporal locus of the interaction between working memory and visual temporal attention by using electroencephalography. In a rapid serial visual presentation task, which is known to elicit the attentional blink, we demonstrated that the attentional blink is more severe when memory load is high. We furthermore observed modulation of several components of the event-related potential. A short temporal lag between target stimuli and an increase of the load on working memory both reduced the amplitude of the P3. This result was consistent with current models of temporal attention and with a functional explanation of the P3 in terms of memory consolidation. The P2 component showed modulation by lag only, but not by memory load. Critically, the N2pc component did show modulation by both lag and load. Thus, these results demonstrated that early attentional processing as marked by the N2pc was suppressed by increased involvement of working memory, which is a phenomenon not well predicted by current theories of visual temporal attention.
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Preparing two movements: Duak task costs do not arise from an attentional bottleneck
D Jonikaitis, H Deubel (Dept of Psychology, Ludwig-Maximilians-University München, Germany;
e-mail: djonikaitis@googlemail.com)
Strong dual task costs are observed when people perform two tasks at the same time. Based on reaction times it has been suggested that movement goal selection is a major factor leading to dual task costs when making multiple goal directed movements at the same time. To investigate this, we asked participants to point and look at two di_erent locations while we varied the time between the cues to start eye and hand movements. Like in previous studies, we observed that participants were slower to start their eye or hand movement if they were planning another movement at that time. Identical results were observed when participants were planning bimanual movements. Second, we measured whether spatial attention caused these observed dual task costs. In strong contrast to the dual task cost observed in movement latencies, participants allocated their attention to eye and hand movement goals in parallel and without any cost. These results demonstrate that observed dual task costs in goal directed movements do not arise from movement goal selection. The results also suggest a dissociation between movement latencies and movement goal selection, in that longer movement latencies do not equate to delayed movement goal selection.
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Factors a_ecting attentional modulation during visual object detection
N Kelly, H A Allen (School of Psychology, University of Birmingham, UK;
e-mail: nxk331@bham.ac.uk)
Auditory cues can improve discrimination at the cued spatial scale (eg Ozgen et al, 2005 Visual Cognition 12 925-937), but can cues improve temporal order discrimination? We used a temporal order judgment task with, and without, an auditory cue. Participants judged which of two spatial filtered shapes (HSF: 6 cpd; LSF 1.4 cpd) was presented first (left or right) as temporal o_set was varied (11–99 ms). Participants were sensitised to the cue prior to the experiment by repeated presentations of pairings of auditory cue

and images containing coherent structure at one spatial scale and noise at the other scale. With no cue, and overlapping shapes, participants correctly reported that the HSF stimulus was first more often than the LSF stimulus ($p>0.01$). With non-overlapping stimuli the LSF stimulus was more often correctly reported as first. Valid cues (50% of trials) selectively improved temporal o_set discrimination ($p>0.05$) such that correct judgments were more likely when the cue was congruent with the earlier stimulus. Sensitisation to a link between an auditory cue and spatial frequency is su_cient to improve detection of information at that scale even for the detection of object stimuli. This implies changes in diagnostically relevant SF channels in early visual cortex.

POSTER SESSION: CONSCIOUSNESS AND RIVALRY

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Individual di_erences in metacontrast masking: Electrophysiological markers

T Albrecht, U Mattler (Georg-Elias-Müller Institute for Psychology, Georg-August University of Göttingen, Germany; e-mail: thorsten.albrecht@biologie.uni-goettingen.de)

Recently, Albrecht, Klapötke, and Mattler (in press Consciousness and Cognition) have shown qualitative individual di_erences in metacontrast masking: In a masked target discrimination task performance increased with stimulus onset asynchrony (SOA) in Type-A observers, but it decreased with increasing SOA in Type-B observers. Here we report event-related potentials (ERPs) which we recorded while participants performed a target discrimination task in a metacontrast paradigm with varying SOAs. To extract the transients induced by the mask, we subtracted ERPs on target-only trials from ERPs on target + mask trials. The two types of observers showed di_erential ERP-e_ects on this measure: In type-B observers we found an occipital P150 which decreased in amplitude when SOA increased. This e_ect was absent in Type-A observers. In Type-A observers, in contrast, we found a fronto-central N200 which decreased in amplitude when SOA increased. This e_ect was absent in Type-B observers. Moreover, on mask-only trials Type-B observers showed a prominent N270, which was absent in Type-A observers. These findings show that the interaction between target and mask elicits di_erent neuronal responses which might result from di_erent top-town influences in the two groups of observers, and which might be related to di_erences in conscious percepts.

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Perceptual awareness lags perceptual decision-making with degraded motion stimuli

C de'Sperati, M Balderi, R Gregori-Grgic, D Agatino (Laboratory of Action, Perception, Cognition, Università San Ra_aele, Italy; e-mail: desperati.claudio@hsr.it)

Recently we revealed an early, transient dissociation between saccades and perceptual localization (blind saccades), which suggested that visuomotor responses can precede perceptual awareness [de'Sperati and Baud-Bovy, 2008 Journal of Neuroscience 28(17) 4317–4321]. By exploiting the long integration time of noisy motion stimuli (random-dot-kinematograms, coherence 0–60%), and by forcing human observers to make speeded discrimination—with saccades or verbally—of motion direction (0.2–1.0 s after stimulus onset), here we compared the buildup of motion discrimination capability and subjective visibility of motion, as assessed trial by trial through direct rating. Both increased with stimulus coherence and viewing time, but the latter had a longer buildup. The discrimination rate was above chance even when motion was subjectively invisible. It made no di_erence whether motion discrimination was accomplished by saccades or verbal responses. Providing a directional precue a_ected both motion discrimination rate and subjective motion visibility. These findings suggest that perceptual awareness requires additional processing of sensory signals, compared to simple perceptual decisions. As a consequence, awareness lags decision.

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The moment of conscious perception

F Imamoglu[1,2], C Koch[3], J-D Haynes[1,4] ([1]Bernstein Center for Computational Neuroscience, Humboldt-Universität Berlin, Germany; [2]Charité, Universitätsmedizin Berlin, Germany; [3]Division of Biology, California Institute of Technology, Pasadena, USA; [4]Max-Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany; e-mail: fatmaimamoglu@gmail.com)

When does awareness for a visual stimulus occur?We report on a new, extended stimulus set of two-tone, Mooney images (Mooney, 1957 Canad. J. Psychol 4 219-26). The single objects in these binary images can be identified abruptly, but only after a significant delay. For a planned fMRI study, we generated a large number of Mooney images for which the moment of recognition occurs within 3–10 s. We selected concrete words from a linguistic database (MRC-Psycholinguistic-Database) and automatically downloaded images tagged with these object names from an image database. Using a smoothing and thresholding process (Otsu, 1979 IEEE Trans. Sys. Man. Cyber 9 62-66), we created a database of 330 ambiguous two-tone images. We obtained psychophysical ratings from 7 subjects to investigate (a) the time of onset of object awareness and (b) the vividness of recognition spanning the entire interval of

3–10 s while also yielding vivid percepts. In an ongoing fMRI experiment we compare neural responses before and after recognition to assess how awareness influences visual and prefrontal brain networks (Crick and Koch, 1995 Nature 375 121-123; Dehaene et al, 2001 Nat. Neurosci 4 752-758; Haynes et al, 2005 Neuron 446 811-821).

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Poster session: Consciousness and rivalry

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Proprioceptive cues at feet, but not arms, modulate a visuotactile illusion of bodily self-consciousness

E Palluel, J-E Aspell, O Blanke (Laboratoire de Neurosciences Cognitives, Brain Mind Institute, École Polytechnique Fédérale de Lausanne (EPFL), Switzerland; e-mail: estelle.palluel@epfl.ch)

Visuotactile conflict between the body of the participant and a fake body has been shown to induce illusory self-identification with the fake body associated with changes in tactile processing (crossmodal congruency e_ect—CCE), see Aspell et al (2009 PLoS One 4 e6488). Here, we investigated whether and how self-identification and tactile processing can be altered by applying 80-Hz vibrations at the lower limbs during synchronous and asynchronous stroking (Study 1). Such vibrations perturb proprioceptive signals by inducing illusions of movements and more reliance on visual and vestibular signals. Our data revealed that 80-Hz vibrations at the ankles during the FBI lead to the disappearance of selfidentification and CCE changes with respect to previous studies. Vibration and synchrony were not found to influence self-identification or CCE significantly. When vibrations were applied at a control site (wrists; Study 2) we did observe predicted changes in self-identification and CCE, but these again did not depend on vibration (as in Study 1). These data show that alteration of proprioceptive lower limb signals may diminish the reliance on visual information during the FBI. We propose that this is due to a vibration-induced higher reliance on vestibular and plantar tactile inputs (and not visual inputs).

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Suppressed images a_ect the dominant percept during binocular rivalry

S M Stuit, M J van der Smagt, F A J Verstraten, C L E Pa_en (Division of Experimental Psychology, Utrecht University, The Netherlands; e-mail: S.M.Stuit@uu.nl)

Dichoptically presented incompatible images result in alternating percepts; a phenomenon known as binocular rivalry. Recent evidence indicates that the level of suppression during rivalry specifically depends on features that induce the interocular conflict. For example, probes in the suppressed image with orientations similar to those in the dominant image are harder to detect than probes that deviate. Here, we test whether the converse is manifest during perceptual dominance, ie whether the orientation of a suppressed image a_ects the percept of a probe in the dominant image. We measured contrast thresholds for a grating probe in a 2AFC orientation-discrimination task performed during rivalry between pixel noise and a grating. The probes, oriented 5 degrees clockwise or counter clockwise from vertical, were superimposed on the noise image when it was dominant. The orientation of the suppressed grating was varied systematically with respect to probe orientation. Probe-orientation discrimination in the dominant image was a_ected more by suppressed stimuli of like orientation (up to 30 degrees deviation). These results imply that (1) during binocular rivalry, the suppressed image a_ects perception of the dominant image, and (2) perception of a dominant image during binocular rivalry di_ers from perception of that same image during monocular viewing.

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Reliable individual di_erences in the perception of ambiguous rotational motion

P T Goodbourn[1], G Bargary[1], J M Bosten[1], R E Hogg[1,2], A J Lawrance-Owen[1], J D Mollon[1] ([1]Dept of Experimental Psychology, University of Cambridge, UK; [2]Centre for Vision Science and Vascular Biology, Queen's University Belfast, UK; e-mail: p.goodbourn@psychol.cam.ac.uk)

We demonstrate a reliable perceptual polymorphism for a class of ambiguously rotating stimuli. Twenty participants reported the perceived direction of rotation of structure-from-motion cylinders and silhouettes of a pirouetting dancer presented briefly to the left or right of fixation. Nearly all participants showed a robust directional bias across two testing occasions. This bias was consistent between presentation locations for most participants, but a minority reliably showed an opposite bias in the two hemifields. Biases were highly correlated between the two stimulus types, though we found some evidence that the initial frame of the pirouetting dancer animation could influence perceived direction on a given trial. In a follow-up study, we tested 1000 participants using the structure-from-motion stimulus. We report the distribution of directional biases observed in this sample, as well as their correlation with measures of handedness, ocular dominance and ideational type. We also report test–retest reliabilities based on a randomly selected subset of 100 participants.

[Supported by the Gatsby Charitable Foundation]

Poster session: Face perception II

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The Necker Cube: E_ects of stimulus size on stimulus and reversal related ERP components
J Kornmeier[1,2], M Pfä_e[3], M Bach[2] ([1]Institute for Frontier Areas of Psychology and Mental Health, Freiburg, Germany; [2]University Eye-Clinic, University Freiburg, Germany; [3]Zoologisches Institut Abtlg Ökologie/Parasitologie, Karlsruher Institut für Technologie (KIT), Germany; e-mail: kornmeier@igpp.de)
During the observation of ambiguous figures sudden perceptual reversals occur while the stimulus stays unchanged. With our recently introduced gap paradigm we could resolve the time course of the neural mechanisms underlying endogenous perceptual reversals. In the present study we analysed the e_ect of stimulus size on stimulus related and reversal related ERPs. Methods: Three Necker cubes di_ering in size were presented discontinuously. EEG was recorded while participants compared the 3D orientation of successively presented cubes and indicated either perceptual reversal or perceptual stability (go–nogo-design). We calculated stimulus related ERPs by averaging EEG across stimulus presentations. Reversal related components resulted from di_erence ERPs (reversal minus stability). Results: The earliest visual ERP (P100) increased with stimulus size whereas the earliest reversal related ERP (reversal positivity, RP, at 130 ms) stayed unchanged. At higher latencies we found mainly e_ects of trial type. Discussion: The ERP e_ects at higher latencies could be explained by a superimposed CNV in the go-trials. The neural processes underlying the RP seem to be independent from those underlying the P100 despite similarities of location and timing. The reversal positivity may rather be independent from the physical stimulus properties and may instead reflect early visual appraisal of stimulus ambiguity.

POSTER SESSION: FACE PERCEPTION II

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How well do we know our own faces?
F M Felisberti, L Bates, J Rabadia, Y Kato, M Schembri (Dept of Psychology, Faculty of Arts and Social Sciences, Kingston University, UK; e-mail: f.felisberti@kingston.ac.uk)
Although mirrors, photographs and proprioceptive information are widely used for feedback about our own faces, surprisingly little is known about self-face recognition thresholds (SFT) for facial features or their spatial relationship (Felisberti, 2009 Perception 38 ECVP Supplement, 80). Here SFT was investigated using digital photographs of participants' faces. Eyes, nose, mouth or chin areas were manipulated either individually or simultaneously. In study 1 (N=16), participants had to choose which of two images (original vs. chimeric) was the original one. In study 2 (N=30), videoclips were created showing sequences of features increasing and decreasing in area. Participants had to stop the videoclips when their original self appeared. Results revealed that SFT was not as good as many individuals expected. SFT was easier when features were made larger ($F_{1,15}$=44.74, p=0.001, n_2=0.75) and for simultaneous changes in eyes, mouth and nose ($F_{4,60}$=6.10, p=0.001, n_2=0.29). SFT for eyes (high contrast region) was usually lower than for mouth, nose and chin. The same pattern of results was found with videoclips, although SFTs in the latter case were overall lower. Most females were more accurate in self-face recognition than males. Further research is needed to uncover the reasons underpinning the strong individual variations in SFTs.

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First step across the categorical border requires higher neural response
O Kurakova (Centre for Experimental Psychology, Moscow City University of Psychology and Education, Russia; e-mail: olga.kurakova@gmail.com)
The interpeak P100-N170 amplitudes of di_erential occipitotemporal visual event-related potentials are larger to subtle physical and perceived di_erences within pairs of morphed emotional facial expressions (FE) that cross the categorical boundary than to larger di_erences in pairs crossing the same boundary. In frontal sites, the N120-P230 amplitudes form V-shaped functions where larger di_erences correspond to larger amplitudes. These results were obtained in electrophysiological experiment where 12 subjects were presented sequences of two faces: (1) 50% happy/50% sad morph, (2) picture of the same poser from 7 (2 prototypes+5 morphs) physically equidistant images continuum. The 50% morphs were perceived as 67% happy/33% sad expressions, and other images were perceived as either happy or sad (90–100%) in forced-choice identification task by 21 subject. We propose that the first subtle appearance of happy/sad recognizable emotion compared to FE which is di_cult to categorize requires higher neural response to perceive and react. We plan to confirm this results and prediction on wider set of natural transitions between basic FE, expressed by trained actors, which have higher ecological validity

than morphed images and can reveal the natural trajectories of facial muscles movements and natural dynamics of expressions.

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Are judgments of kinship from faces primed by visual similarity?
L Lorusso[1,2], L Brodo[3,2], E Grosso[1,2], G Brelsta_[4,2], A Lagorio[1,2] ([1]DEIR Dept, University of Sassari, Italy; [2]Computer Vision Laboratory, University of Sassari, Italy; [3]Dept of Science of Languages, University of Sassari, Italy; [4]CRS4, Sardinia, Italy;
e-mail: ludovica.lorusso@gmail.com)
We investigate di_erences in visual judgments of faces pertaining to kinship, similarity and di_erence—by measuring reaction times for those three judgments, and by examining priming e_ects occurring between them. Does a judgment about similarity, or physical di_erence, prime a judgment about kinship, or vice versa? Participants judged a sequence of face-pair presentations selected randomly from genetically related people, and from similar and di_erent categories—these latter were calibrated as such by subjects in a preliminary presentation. Priming e_ects were investigated at the end of each sequence by repeating a selection of the face-pairs and altering the task from 'are they of same kin' to 'are they similar' or 'are they di_erent'. Significant di_erences in reaction time were found both between the three di_erent tasks and face-pair categories—suggesting that the strategies we employ when extracting information from facial features may be conditional on both task and stimulus context. A strong association was found between similarity and kinship judgments, but not between judgments of di_erence and kinship. All of which may implicate a top-down mechanism that links similarity to kinship judgments. Which, as such, would complement the widely studied bottom-up model in which kin signals are based on similar features.

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Mediated eye-contact is determined by relative pupil position within the sclera
R H Cuijpers, D van der Pol, L M J Meesters (Human Technology Interaction, Eindhoven University of Technology, The Netherlands; e-mail: r.h.cuijpers@tue.nl)
It is well-known that Mona Lisa's gaze follows you around as you walk by her portrait. Perception of gaze direction has gained renewed interest in the context of videocommunication. We investigated people's tolerance for eye contact while looking at slanted images of a female face. We found that the region of eye contact is about 7° wide independent of image slant (up to 60°). Consistent with the Mona Lisa e_ect the region of eye contact hardly shifts with image slant. The small but significant shift is well explained by the e_ect of image slant on the relative pupil position. We also measured how people perceive gaze directions. Subjects had to hold a target in the apparent line of sight of the depicted face while we varied the horizontal head location, head orientation and eye turn. We found that the Mona Lisa e_ect, to a first approximation, holds for any depicted gaze direction. The displacement of the handheld target with head location had a modest gain of 0.22. However, the gain between perceived and simulated gaze direction was 1.95, and the head orientation gain was −0.48. These results suggest that observers directly judge the relative pupil position within the sclera.

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Influence of eye-makeup on the perception of gaze direction
S Ueda, T Koyama (Faculty of Integrated Arts and Social Science, Japan Women's University, Japan; e-mail: sueda@fc.jwu.ac.jp)
There is evidence that makeup has a beautifying e_ect on facial attractiveness (Cash et al, 1989 Journal of Social Psychology 129 349-356; Guéguen, 2008 North American Journal of Psychology 10 221-228; Nash et al, 2006 Journal of Applied Social Psychology 36 493-504). Does wearing eye-makeup influence the perception of gaze direction? Eye-makeup might make gaze more recognizable, by emphasizing the contrast of the eyes. Or makeup might make gaze less recognizable, by transforming eyes to unnatural shapes. In an experiment, stimuli were created in three makeup conditions: no-eyeliner, thin-eyeliner, and thick-eyeliner. Each trial began with a visual cue for 500 ms followed by the first face for 150 ms. Then a mask was displayed for 500 ms, and then the second face appeared. It remained on the screen until the observer made a recognition response of whether the two faces' gaze direction were the same or di_erent. Half of the trials were pairs of the same gaze direction, and the other half were di_erent gaze direction. The results show that thick-eyeliner made it easier to recognize gaze direction, in the same gaze direction pairs, and thick-eyeliner made it more di_cult to recognize changes of gaze direction, in di_erent gaze direction pairs.

Poster session: Face perception II

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Accurate perceptions of personality from the static face
R Ward, R S S Kramer (School of Psychology, Bangor University, UK;
e-mail: r.ward@bangor.ac.uk)
The face is designed to signal transient emotional states by changes in expression. However, static properties of the face can also signal more stable socially-relevant traits, like personality. For example, a stranger's level of extraversion can be identified solely from a static image of the face with neutral expression. We investigated where such socially-relevant information is carried, by comparing

information content within internal facial features and the full face. We created composite images from women scoring high and low on personality and health scales, and measured the accuracy of raters in discriminating the high from the low composites. Physical health and four of the 'Big Five' personality factors were accurately discriminated from internal facial features alone (conscientiousness was the exception). Static properties of the face therefore reliably signal personality, which in turn predicts behavioural biases across a range of contexts. These results are discussed in terms of a biological signalling perspective, considering the benefits to both the sender and the receiver of this visual information.

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Investigating the double face illusion
P J B Hancock, C Foster (Dept of Psychology, University of Stirling, UK;
e-mail: pjbh1@stir.ac.uk)
We investigate the 'double face' illusion, where the eyes and mouth are duplicated. On an identification task for briefly (80ms) presented faces, there are strong individual di_erences: doubling has little e_ect for the majority, but inhibits recognition for about a quarter of participants. A second experiment shows that some participants are unable to detect face doubling at this speed, while others are 100% correct at 50 ms. Unlike the Thatcher illusion, a doubled face is still obvious when inverted, but it is less unsettling to look at and a third study found that participants were about 35 ms faster to decide that a face has been doubled when it is inverted. A final experiment tested visual search for normal and doubled faces; neither pops out from the other and the search time per item is again about 35 ms longer for double faces.

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The time course of aftere_ects for emotional facial expressions
K Minemoto[1], S Yoshikawa[2,1] ([1]Graduate School of Education, Kyoto University, Japan; [2]Kokoro Research Center, Kyoto University, Japan; e-mail: k-mine@a06.mbox.media.kyoto-u.ac.jp)
This study explores the decay of aftere_ects over time for four emotional facial expressions (anger, fear, happiness and sadness). The previous study (Minemoto and Yoshikawa, 2008 Perception 37 ECVP Supplement, 173) shows that the thresholds for facial expressions were changed by adaptation to the same facial expressions and that the aftere_ects were strengthened as a function of adaptation time. However, the decay processes of the aftere_ects for facial expressions have not yet been explored. In the present study, one of the four facial expressions was presented for 5 s as an adaptation stimulus, followed by a 200 ms presentation of a test stimulus. The test stimuli were images of facial expressions in which the emotional intensity was weakened. The interstimulus intervals of these two stimuli were 200, 400, 800, 1600, and 3200 ms. Participants were asked to identify the test stimulus from forced-choice labels. We found that the aftere_ects of all facial expressions did not decay for at least 3200 ms after the end of adaptation stimuli. Taken together with the fact that the aftere_ects of identity decay over time [Rhodes et al, 2007 Vision Research 47(14) 2291-2296], the underlying mechanisms of the aftere_ect of facial identity and facial expressions may have di_erent time course characteristics.

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Representing facial information using Gabor wavelets
R Stollho_ (Group: Complex Structures in Biology and Cognition, Max Planck Inst. for Mathematics in the Sciences, Leipzig, Germany; e-mail: rainer.stollho_@mis.mpg.de)
In recognizing faces human observers extract facial information from di_erent locations, spatial scales, and across di_erent orientations. In experimental investigations these aspects have mostly been studied in isolation using techniques such as Bubbles (Gosselin and Schyns, 2001 Vision Research 41(17) 2261-2271), or bandpass-filtering of the Fourier spectrum. Here, a novel method to conduct an integrated investigation of these aspects is proposed and demonstrated in a simplified optimal observer model of facial information processing. Central to the method is a representation of face images by a family of Gabor wavelets modeled to mimic filter response profiles of simple cells in V1 [Lee, 1996 IEEE T Pattern Anal 18(10) 959-971]. In a simulation study using standardized face images, two properties of the wavelets were studied: Informativeness, calculated based on activation di_erences across faces,

and robustness, calculated as the variability in activation across di_erent levels of in-depth rotation. In general, wavelets displaying high informativeness and robustness are characterized by medium spatial frequencies, horizontal orientations - extracting vertical information, and clustering around diagnostic regions (eyes, mouth, ...). These results agree with similar findings in psychological experiments, and can provide a normative rationale for known specifics of human face processing.

m
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Anticipating action sequences based on the actor's gaze direction in individuals with high-functioning autism spectrum disorder

M Hudson, H Burnett, T Jellema (Dept of Psychology, University of Hull, UK;
e-mail: m.hudson@2005.hull.ac.uk)
Gaze direction is a cue to the goals underpinning an observed action and contributes to the anticipation of how the action will continue. It has been suggested that individuals with Autism Spectrum Disorder (ASD) exhibit an impaired ability to process the psychological significance of gaze. However, it is unknown whether individuals with high-functioning ASD (ADOS scores from 7 to 9) are impaired. In this study participants observed either a head or a control object rotating 60° toward them. The gaze direction of the head (and the equivalent of gaze in the control object) was manipulated (congruent, lagging behind or in advance of rotation). A significant e_ect of gaze on estimations of head rotation was found in both high-functioning ASD and typically-developed (TD) groups: head rotation was underestimated for gaze lagging compared to gaze in advance. In both groups the manipulation did not a_ect estimations of how far the control object had rotated. The results suggest that individuals with high-functioning ASD do show a tendency to involuntary anticipate the future course of actions on the basis of the actor's gaze direction. However, the degree to which they did so was significantly smaller than in the TD group.

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The other-race e_ect for artificial faces

H Wang[1], R Stollho_[2], T Elze[2] ([1]Psychology Dept, Jilin Unniversity, China; [2]Group: Complex Structures in Biology and Cognition, Max Planck Institute for Mathematics in the Sciences, Leipzig, Germany; e-mail: huiwangedu@hotmail.com)
The other race e_ect (ORE), that is worse recognition of other-race faces compared to own-race faces, is commonly explained by greater familiarity with own-race faces and is known to decrease with increasing experience with faces of the respective other race. Usually, the e_ect is experimentally studied with photographs of own- and other-race faces. Here, we investigate whether the ORE can be observed for artificially generated faces using FaceGen software. We generated 96 European-looking and 96 East Asian-looking artificial faces and performed two recognition experiments (delayed match-to-sample) and one race classification experiment. In the first recognition experiment, face stimuli were presented blockwise according to race whereas in the second experiment presentation was intermixed in random order. We found that artificially generated faces can evince an ORE contingent on the ability to sample naturally looking faces from any specific population. Furthermore, the ORE was only observed for blockwise presentation. In addition, we found a positive correlation for own-race faces that was reversed for other-race faces, which is compatible with the familiarity hypothesis: Increased experience with own-race faces results in both better discriminability and classification. Conversely, unfamiliarity with other-race faces eases classification but diminishes identification.

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Perception of facial expressions in people with high autistic traits

E Poljac[1,2], H R Zini[2], J Wagemans[1] ([1]Laboratory of Experimental Psychology, University of Leuven (KU Leuven), Belgium; [2]Psychology Dept, International University of Sarajevo, Bosnia and Herzegovina; e-mail: Ervin.Poljac@psy.kuleuven.be)
Autism is a disorder characterized by specific impairments in emotional processing such as interpreting emotional expressions. We employed the autism spectrum quotient (AQ) (Baron-Cohen et al, 2006) to quantify autistic traits in a group of 260 students to investigate whether this measure is related to the perception of facial emotional expressions. The emotional processing of a group of twelve students scoring significantly higher than the average on the AQ was compared to a group of twelve students with significantly lower scores using the facial recognition task (Montagne et al, 2007). This task consists of short video clips of a neutral face changing into the full-blown expression of one of the six basic emotions (anger, disgust, fear, happiness, sadness, and surprise). We found di_erences between the two groups in accuracy and sensitivity of the perception of emotional facial expressions. The group with the higher AQ score were less accurate and needed higher emotional content to recognize emotions of anger, disgust, happiness and sadness.

Poster session: Face perception II

Wednesday

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m

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Perception of Mooney face by 3- and 4-month-old infants: the role of local features, contrast polarity, and motion

Y Otsuka[1], H Hill[2], S Kanazawa[3], M K Yamaguchi[4], B Spehar[1] ([1]School of Psychology, University of New South Wales, Australia; [2]School of Psychology, University of Wollongong, Australia; [3]Dept of Psychology, Japan Women's University, Japan; [4]Dept of Psychology, Chuo University, Japan; e-mail: yumikoot@gmail.com)
We examined the ability of 3- and 4-month-old infants to detect faces from the two-tone facial images known as Mooney face (Mooney, 1957 Canadian Journal of Psychology 11 216–226). As pilot work showed no evidence of facial detection from the original Mooney face, we created a series of two

tone facial images designed to investigate when infants can detect two-tone faces. Specifically, we manipulated luminance threshold and background color to determine the role of isolated facial features and head outline in facial detection. In each condition, upright and inverted two-tone facial images were shown side by side for two 20 s trials. Infants showed a preference for upright images when some isolated facial features were visible, but not when facial features were merged with the rest of face as for Mooney faces. The presence or absence of head outline did not a_ect detection. However, when two depth rotated images were alternated giving the impression of rigid rotation, infants showed the upright preference even without isolated facial features. This preference disappeared for contrast negated versions of stimuli. The results show that 3- and 4-month-olds can detect faces from incomplete two-tone images when either isolated facial features or dynamic information is available.
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How do prototypes of visual objects develop and establish? Exemplars perceived early in life might have an essential influence

B E Wirth, C-C Carbon (Dept of Psychology, University of Bamberg, Germany; e-mail: ccc@experimental-psychology.com)

Prototypes play an important role in many theories of visual perception. These prototypes are defined as results of principal components or as averages of all perceived instances. Though these approaches seem promising the results of three empirical studies contradict both assumptions. In studies 1 and 2 participants were asked to sketch the 'prototypical face they have in mind'. In study 3 participants were shown two average faces which they had to draw from memory 30 seconds after the presentation. In all three studies participants' depictions showed systematic distortions from the average face. A potential explanation of these deviations might be an essential influence of instances perceived early in life on prototypes. Due to their height children normally perceive faces of adults from the bottom up and therefore distorted. In a fourth study we measured faces appearing in German picture books and found again systematic distortions children are exposed to, highly compatible with the bias found in studies 1–3. In a fifth study participants of three di_erent age cohorts drew the 'prototypical landline phone they have in mind'. Participants depicted phones compatible with phones originating from their experiences in childhood, thus supporting our hypothesis of strong influences of early experiences in forming prototypes.

m

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The time course of the face inversion e_ect for horizontal, vertical and featural relations

G Meinhardt[1], B Meinhardt-Injac[2], M Persike[1], S Mayer[1], T Dienlin[1] ([1]Dept of Psychology, Methods Section, University of Mainz, Germany; [2]Dept of Psychology, University of Zürich, Switzerland; e-mail: meinharg@uni-mainz.de)

It was found recently that facial features and their spatial relations are di_erently vulnerable to inversion (Go_aux and Rossion, 2007). Manipulations of vertical relations are hard to detect when faces are upside down, while just moderate performance deficits are found with inverted faces when they are manipulated in horizontal relations, or their features di_er. Here we study the temporal course of performance and the inversion e_ect in all three kinds of manipulations. We find rapidly rising performance for featural manipulations, reaching a 75% accuracy level at presentation times of about 80 ms. Detecting changes of horizontal and vertical relations is slower, with more gradually rising performance that takes identical courses for both kinds of relational manipulations. Inversion e_ects arise immediately for vertical relations and featural changes. For horizontal relations inversion e_ects are absent at brief timings, but arise later, after about 200 ms. The results corroborate recent findings of early holistic processing (Richler et al, 2009), but, in contrast to recent suggestions (Riesenhuber et al, 2004; Riesenhuber and Wol_, 2009), indicate di_erential handling of featural and configural information. We propose that face processing modes are channeled by cues contained in the early part of the face specific visual response.

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Compatibility of context sizes in face perception—a di_erent perspective on holistic e_ects

R N Kaltenbach, C-C Carbon (Dept of Psychology, University of Bamberg, Germany; e-mail: ruth-nikola.kaltenbach@stud.uni-bamberg.de)

The holistic hypothesis is one of the most noted hypotheses in face processing, empirical proof being provided by the whole-to-part superiority (Tanaka and Farah, 1993). Leder and Carbon (2005) investigated whole-to-part superiority in face recognition and found evidence suggesting compatibility between learn and test conditions as an important factor. The present study further investigates the compatibility hypothesis in face perception, using a sequential matching paradigm. Context sizes for prime and target were fully crossed on the levels 'eyes' (eyes region only), 'eyes & nose' (eyes & nose region) and 'full' (whole face). Faces were matched on distinctiveness, attractiveness and typicality, based on a preliminary rating study (N=10). The main study (N=36) revealed systematic compatibility

e_ects on reaction times: the more compatible the two contexts of a trial were, the faster participants reacted. The RT data thus supports the idea that holistic e_ects can mainly be explained by compatibility e_ects.

POSTER SESSION: HAPTICS

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Visuohaptic integration in softness estimation of softness of deformable objects
C Cellini, L Kaim, K Drewing (Dept of General Psychology, Justus-Liebig-University, Germany; e-mail: Cristiano.Cellini@psychol.uni-giessen.de)
Softness perception intrinsically relies on haptic information. Everyday-life experience teaches us some correspondence rules between perceived softness and the concurring visual e_ects of exploratory movements that are executed to feel softness. We investigated whether and how the brain integrates visual and haptic information while estimating the softness of deformable objects. We created 2 sets of rubber specimens, whose compliance varied in a controlled fashion: a hard set (0.12 to 0.25 mm/N) and a soft set (0.74 to 1.26 mm/N). In the experiment, participants touched these real stimuli, while they watched a simulation of their finger movements and stimulus deformation on a collocated visual 3D display. The experiment used the method of constant stimuli combined with a 2AFC task: participants always explored two stimuli and judged which one was softer. They either used haptic and visual input simultaneously, only haptic input, or only visual input. Input in the visual-only condition was based on movement sequences in previously run visuo-haptic trials. In the visuo-haptic conditions, we introduced slight discrepancies between visual and haptic compliance information. The results suggest that visual and haptic inputs are integrated to form visual-haptic softness estimates. Moreover, the visual weight is larger for soft as compared to hard stimuli.
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E_ects of visible contact point on visual–haptic integration in 3D shape perception
J Liu, H Ando (Universal Media Research Centre, NICT, Japan; e-mail: juanliu@nict.go.jp)
This study investigates the influence of a visible contact point on integrating visual and haptic information in 3D shape perception using a force-feedback device and stereo shutter goggles. Virtual stimuli were pair-wise presented fixed haptic surfaces and various visual surfaces whose coronal sections were described by hyperpolic tangent function with di_erent inclination and amplitude. A small sphere, which followed hand movements on the haptic surface while its position complied with the visual surface, was visible in one condition and invisible in the other. It gave subjects the illusion of contact point on the visual surface. Subjects were asked to freely explore and judge whether the two surfaces were the same or not, and if not, which surface was steeper or higher. Adaptive staircase procedure was applied to obtain the range of inclination and amplitude in which subjects could not sense the incongruity of the surfaces they were looking at and touching. The ranges expanded when the contact point was visible, averagely 155% and 265% of the values of the other condition for inclination and amplitude, respectively. The results suggest that the visible contact point plays an important role in jointing vision and touch information to form an integrated representation.

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Influence of 3-D objects’ shape on weight perception
M Kahrimanovic, W M Bergmann Tiest, A M L Kappers (Physics of Man, Helmholtz Institute, Utrecht University, The Netherlands; e-mail: m.kahrimanovic@uu.nl)
The size-weight illusion has been studied since 1891 (for overview see (Murray et al, 1999 Perception & Psychophysics 61 1681-1685)). Recently, Kahrimanovic et al (2010 Attention, Perception, & Psychophysics 72 517-527) demonstrated the existence of another perceptual phenomenon: the haptic

shape-size illusion. Based on these illusions, we hypothesized that the perceived weight of objects should (besides their mass) not only depend on their size but also on their shape: the shape-weight illusion. The present study investigated a possible existence of this illusion with 3D objects, which subjects could explore freely. We tested whether this illusion could be explained by a combination of the shape-size and the size-weight illusions, and whether the e_ect is altered by the availability of visual cues, compared to a purely haptic condition. Fourteen subjects participated in both a haptic and a bimodal condition. They were presented with tetrahedrons, cubes and spheres (16.8–117.6 g). A magnitude estimate of perceived weight was obtained on each trial. The results showed a significant e_ect of objects’ shape on the perceived weight. However, this e_ect could not be explained entirely by a combination of the former two illusions. Similar patters are observed in the haptic and bimodal conditions.
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Choice blindness for haptically presented objects
C Steenfeldt-Kristensen, I M Thornton (Dept of Psychology, Swansea University, UK;
e-mail: 482158@swansea.ac.uk)
Choice blindness is the failure to notice a mismatch between intention and outcome when making decisions [Johansson et al, 2005 Science 310(5745) 116–119). In the original task, participants were asked to choose which of two facial photographs they found more attractive. While justifying this choice, the preferred and non-preferred images were sometimes switched. Only about 25% of such manipulations were typically detected. In the current work, we asked if choice blindness occurred with common 3D objects that were felt rather than seen. Participants placed their hands inside a specially constructed box that had two individual compartments. They were told to feel the two objects, remove their hands and then indicate a preference. On some trials they were asked to again feel the preferred object and justify why it had been selected. A silent turntable was used to switch objects between choice and justification. For similar pairs of objects, we found detection rates of around 22%, but for pairs consisting of more distinctive exemplars, this rate rose to 70%. A control experiment confirmed that similar pairs were easily distinguishable from identical pairs. Our results suggest that object complexity and similarity strongly modulate the occurrence of choice blindness.

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'Feeling by seeing': Reconstructing haptic sensing by non-attentive visual method
M Wagner[1], S Shoval[1], E Porat[2] ([1]Dept of Industrial Engineering and Management, Ariel University Center, Israel; [2]Dept Cardiothoracic Surgery, Rabin Medical Center, Petah-Tikva„ Israel; e-mail: wag.michael@gmail.com)
E_ectiveness of minimally invasive surgery robots is limited by the surgeon's lack of haptic sensation while remotely operating the robot. Thus, reconstruction of haptic sensation has become an important research goal. Here we report an experiment in which visual stimuli successfully evoked haptic sensation. Participants tracked predefined paths on silicon surfaces, while maintaining constant stylus pressure. Visual feedback on pressure was provided as a color signal (color performance-lines displayed on the task screen) and as a frequency signal (pulsating ellipses displayed on a unique haptic sense display (HSD) developed for this study). The HSD was positioned peripherally at a 40 deg visual angle, and a secondary 'Landolt C' detection task ensured that HSD was unattended. Comparing acquisition phase performance with trials (HSD-only, color-line-only, and no-feedback conditions), pressure was e_ciently maintained in the color-line-only condition, as expected, and in the HSD-only condition. Performance significantly declined in the no-feedback condition. Further test phases utilizing virtual surfaces (no contact between stylus and tracking surface), yielded similar results and subjective haptic sensation reports. Our results indicate a crossmodality processing of haptic sensation, induced by a non-attended peripheral-visual stimulus.

m
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Touched by the moment? Factors modulating haptic and visually-based mere exposure e_ects
M Jakesch[1], C-C Carbon[2] ([1]Faculty of Psychology, University of Vienna, Austria; [2]Dept of General Psychology and Methodology, University of Bamberg, Germany;
e-mail: martina.jakesch@univie.ac.at)
Zajonc (1968 Journal of Personality and Social Psychology 9 1-27) showed that the attitude towards stimuli to which one has previously been exposed is more positive as compared to novel stimuli. This mere exposure e_ect (MEE) has been tested extensively using various visual stimuli. However, research on MEE is sparse for other sensory modalities. We used objects of two material categories (stone and

wood) and two complexity levels (high and low) to test the influence of exposure frequency (F_0=novel stimuli, F_2=stimuli exposed twice, F_{10}=stimuli exposed ten times) under two sensory modalities (haptics only and haptics & vision). Participants' "need for touch" [Peck and Childers, 2003 Journal of Consumer Research 30(3) 430-442] was also measured. E_ects of exposure frequency were found for highly complex stimuli with significantly increasing liking from F_0 to F_2, and F_{10}, but only for the stone category. Analysis of the 'need for touch' data showed e_ects in participants with high need for touch, which suggests di_erent sensitivity or saturation levels of MEE. This might also reflect the e_ects of expertise on the haptic evaluation of objects. It seems that haptic and cross-modal MEEs are influenced by factors similar to those in the visual domain.

m
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Studying force perception in a visual–haptic coupling framework for chemistry simulation
D Mazza (Dept of Electronics and Information, Politecnico di Milano, Italy;
e-mail: davide.mazza@polimi.it)
Haptic devices have found room for applications in simulations of physical systems, as can be found in literature [Laycock and Day, 2007 Computer Graphics Forum 26(1) 50-65]. In this work, a study of

how force perception may be influenced by visual cues is performed. The case study was a chemistry simulation tool, showing a 3D model of a molecule and modelling an electric charge moving around it; the user can feel the force of the interaction. Through a set of tests, visual elements have been incrementally added, in order to make users catch more precisely the force information (intensity, direction) conveyed with the haptic device. Users were adult persons of both sex, aged between 20 and 50. With only haptics, users could perceive the feeling of being attracted or repulsed; moreover, users claimed a significant spatial disorientation. Addition of visual cues improved perception: molecule representation was decorated with colors depending on electrostatic potential values. A logarithmic color-scale associated to values interval was adopted, as from Weber–Fechner theory. The introduction of a graphical arrow (vector) indicating force direction makes users able to correctly perceive all the information about the felt forces. Also users orientation has been improved with the addition of visual cues.

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Do the Gestalt principles of proximity and similarity apply in serial haptic search?

K E Overvliet, R T Krampe, J Wagemans (Laboratory of Experimental Psychology, University of Leuven (KU Leuven), Belgium; e-mail: krista.overvliet@gmail.com)

This study aims to investigate whether the Gestalt principles of perceptual organization also apply in the haptic modality. In the current experiment we focus on two of these principles: grouping by proximity and grouping by similarity. To do so, participants performed a haptic search task in which they scanned two columns of ten items with both index fingers. In one of the columns a target was present, the other column consisted of distractors only. The participants' task was to detect the target. We hypothesized that search times are faster when the two columns of items can be grouped. We therefore varied the distance between the two columns to test the principle of proximity. Moreover, we varied the type of items in the distractor column (same or di_erent to the distractors in the target column) to test the principle of similarity. We did not find an e_ect for distance between the columns. However, we did find faster search times when the items in the two columns were the same. These results indicate that in the current experiment the principle of proximity may not apply, but the principle of similarity does.

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Hand movements during haptic object exploration

W M Bergmann Tiest[1], J F Norman[2], M Kahrimanovic[1], A M L Kappers[1] ([1]Physics of Man, Helmholtz Institute, Utrecht University, The Netherlands; [2]Dept of Psychology, Western Kentucky University, USA; e-mail: W.M.BergmannTiest@uu.nl)

The aim of this experiment was to find a link between hand movements and specific types of information acquired during haptic exploration of 2D objects. A set of 18 objects of di_erent shape, size, texture, orientation, and material were created on A4-sized cards. The objects were either fixed or could move with respect to the card. On each trial, two of these objects were presented to a blindfolded subject who was asked to determine whether or not there was a di_erence between them in terms of either coldness, elasticity, hardness, movement, shape, shape orientation, size, texture, or texture orientation. Index finger and thumb movements were recorded. An algorithm was designed to derive the type of desired information from these recordings using simple statistical measures such as standard deviation or kurtosis of movement direction, speed distribution, or average speed. Correctness of the algorithm's prediction varied with the type of information and the subject. Coldness, shape, and texture orientation could be

well identified, with prediction correctness well above chance level. This shows that prototypical hand movements can be identified and related to statistical measures.

[Supported by NWO Vici grant]

POSTER SESSION: IMAGING

m

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Vision cortex stimulation by an artificial vision neural network

F Fayad, R Achkar (Research Center, ASD Vision Institute, USA; e-mail: fadi.fayad@asdvi.us)

The aim of this project is to restore some vision to the visually impaired, via non-invasive digital stimulation. Combining neuroscience with innovative engineering technologies, our ultimate goal is to improve the quality of life for patients with serious vision problems. Our approach is to transmit processed information to the vision cortex, via the transcranial magnetic stimulation (TMS) technique which is a non-invasive method to excite the elementary unit of the nervous system. The back-feed of the vision neural system is done through a complicated artificial vision neural network (AVNN) of interconnected cells generating images that help the vision impaired to recognize objects. This artificial neural network will adapt the information to a form suitable to be sent by the array of electrodes wirelessly to the brain. A neuron to neuron communication is applied. Neural network has the advantage of learning, ie to adapt to new situations even if these situations are not learned with the network during

the training phase. The function and the structure of the AVNN are similar to the neurons of the vision system, which can be replaced by a well learned network. This network is fed by the 3D image provided by a digital stereo vision system.

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Restoring plasticity in the human amblyopic cortex: e_ect of Theta bursts

S Clavagnier[1], B Thompson[2], R F Hess[1] ([1]McGill Vision Research, Dept Ophthalmology, McGill University, Canada; [2]Dept of Optometry and Vision Science, University of Auckland, New Zealand; e-mail: simon.clavagnier@mcgill.ca)

Recently, Thompson et al (2008 Current Biology 18 1067-1071) showed that repetitive transcranial magnetic stimulation (rTMS) improved contrast sensitivity in adult with amblyopia. Their protocol involved either delivering 600 pulses with 85% of the maximum machine output (MSO) intensity at a frequency of 1 Hz during 10 min or 900 pulses with 69% MSO at 10 Hz during 15 min. The purpose of the present study was to improve the e_ciency of rTMS using Theta burst sequences (TBS). 600 pulses at 41% MSO intensity was delivered at 50 Hz as bursts of 3 pulses repeated 5 times a second for 40 s on the visual cortex of four amblyopic participants. Contrast sensitivity was measured before and after TBS using high (SFh) and low (SFl) spatial frequency stimuli. No e_ect was observed on the contrast sensitivity of the fellow eye either at SFl or at SFh, or for the contrast sensitivity of the amblyopic eye at SFl right after TBS stimulation or 30 min after. However there was a significant improvement on the contrast sensitivity of the amblyopic eye at SFh started 30 min after TBS stimulation ($T=5.66$, $p<0.05$). The e_ect lasted at least 24 hours ($T=3.66$, $p<0.05$).

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Combining TMS and EEG: A touchstone for artifact removal

S Marchesotti, G Plomp, M H Herzog (Laboratory of Psychophysics, Brain Mind Institute, École Polytechnique Fédérale de Lausanne (EPFL), Switzerland; e-mail: silvia.marchesotti@epfl.ch)

To understand how single pulse TMS a_ects brain dynamics, we combined TMS with EEG. However, removing TMS artifacts from the EEG is tricky. Here, we tested whether PCA can be used to remove the TMS artifact within the short time window of 50 ms after the pulse. We applied single pulse TMS to one observer and recorded EEG with 32 channels. We then analyzed the data using PCA and found that based on time-courses and amplitudes, three principal components were clearly caused by TMS. From these components we created a dataset to model the TMS artifact. To evaluate how well this artifact could be removed from an EEG signal, we added the model dataset to EEG data of a visual evoked potential paradigm (no TMS). We ran PCA over this 'contaminated' dataset and removed the first three components. Ideally, the cleaned data should show the same evoked activity as the original data. However, this was clearly not the case. Although a positive outcome of this simple test would not provide a su_cient proof of quality of an artifact removal method, our negative outcome puts in question the use of PCA to remove the TMS artifact within the 50 ms period after the pulse application.

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Single trial analysis of attention deployment

E Thunell, G Plomp, M H Herzog (Laboratory of Psychophysics, Brain Mind Institute, École Polytechnique Fédérale de Lausanne (EPFL), Switzerland; e-mail: evelina.thunell@epfl.ch)

Attention to an object can strongly modulate the neural processing of this object. Using average EEG, it was shown that small di_erences in the focus of attention yield large and long lasting changes in brain dynamics (Plomp et al, 2009). Here, we show that these changes can successfully be decoded on the single trial level by combining Fisher linear discriminant (FLD) analysis with principal component analysis (PCA). We presented two expanding streams of lines originating at one central element. In each trial, a cue indicated to which stream observers had to attend. The last elements of the two streams were only half a degree of visual angle apart from each other, so that the attention shift was within a quarter degree. Still, we could decode the focus of attention (left, right stream attended) with a precision of almost 80% on average. Highest precision was obtained between 100 and 150 ms after stimulus onset. Because the stimulus was identical in both cueing conditions, we show that it is possible to decode internally generated attention signals from single trial EEG.

[This work was supported by ProDoc 'Processes of Perception']

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N2pc modulations by context-based redundancy gains

J Krummenacher[1], A Grubert[1], T Töllner[2], M Eimer[3] ([1]Dept of Psychology, University of Fribourg, Switzerland; [2]Dept of Psychology, Ludwig-Maximilian-University Munich, Germany; [3]Birkback College, University of London, UK; e-mail: joseph.krummenacher@unifr.ch)

In visual search for a singleton feature target, search reaction times to targets defined in two compared

to one dimension are substantially faster; a finding referred to as the redundant signals e_ect (RSE). According to the dimension weighting account (Müller et al, 1995 Perception & Psychophysics 57 1-17), the RSE is assumed to arise (i) at a pre-selective processing stage that follows dimension-based (ii) saliency representations. The first assumption (i) was recently tested in an EEG study in which modulations of the perceptual N2pc by redundant relative to non-redundant signals, but no modulations of the response-related LRP component, were found. The prediction that responses are based on saliency signals (ii) receives further support from the analysis of event-related potentials of the present experiment: The target-identity remained the same while the context was varied across trials; distractors di_ered from the target in one (color or orientation) or two (color and orientation) dimensions. Under these conditions a feature search mode (excluding reaction time variability) could have been adopted. However, behavioral results revealed redundancy gains. More importantly, behavioral e_ects were reflected in a substantial latency shift of the N2pc generated in redundant displays. No modulation of the stimulus- or response-locked LRPs was observed.

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The dependence of psychophysical and electrophysiological data on the presentation time of random and ordered Gabor matrices

T V Selchenkova, A K Harauzov, Y E Shelepin (Vision Physiology Dept, Pavlov Institute of Physiology, Russian Academy of Sciences, Russia; e-mail: tatiana.selchenkova@gmail.com)

The aim was to find event-related potential's (ERP) correlates of image discrimination and to estimate the temporal characteristics of this process. The test images were matrices 10×10 Gabor patches with di_erent orientation. Three types of matrices di_ering in the number of Gabor patches with the same orientation (8, 24, 56%) were used. The stimuli were presented for 30, 60, 130, 250, 500, 1000 ms against a background of the random matrices (8%). The observer's task was to discriminate the predominant—vertical or horizontal—orientation of matrix. The participants di_ered in ability to do this discrimination. The presentation time, when all volunteers coped with task, was 130 ms. The first di_erence in ERPs that depended on the type of matrices appeared 300 ms after onset of the stimuli. The amplitude of P300 was greater in response to the textures more simple for discrimination (56 Gabor patches with the same orientation). The coincidence of time thresholds of recognition and first di_erences in ERPs allow us to suppose that the components of ERPs could reflect an activity of image recognition processes. According to our results these processes activate 300 ms after presentation of the stimuli.

Poster session: Imaging

Wednesday

135

m

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Latency of pattern-reversal and orientation-specific VEPs in adults and infants

J Lee[1], D B Birtles[1,2], J Wattam-Bell[2], J Atkinson[2], O J Braddick[1] ([1]Dept of Experimental Psychology, University of Oxford, UK; [2]Visual Development Unit, Dept of Developmental Science, University College London, UK; e-mail: jin.lee@psy.ox.ac.uk)

Pattern-reversal (PR-)VEPs are present in newborns, while orientation-reversal (OR-) VEPs, emerge around 5 weeks of age (Braddick et al, 2005 Vision Research 45 3169-3179). Comparing the latency of these signals can reveal whether extra processing for orientation selectivity extends the time to generate response, and the factors determining developmental changes of latency. OR- and PR-VEPs tested in 85 adults at 1–4 reversal/s (r/s), showed no significant latency di_erence in the initial positive peak for each signal, suggesting that these arose from a similar level of visual processing. For 53 infants aged 4–27 weeks, both latencies showed a systematic decrease with age, but OR latencies were longer and unlike PR did not asymptote to adult values within this age range. Apparent latencies were also calculated from the gradient of phase vs temporal frequency of 0.5–19.2 r/s. In adults the calculated latency is similar to the transient peak latency for PR, but indicates a longer delay for OR when estimating the overall timing of the waveform beyond the initial peak. We will discuss the application of this approach to infant ORand PR-VEPs, and the implications of our data for the maturation of visual cortical processes in infancy.

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m

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Polarity-sensitive activation maps for the multifocal visual evoked potential

S Islam[1], D A Poggel[1], M B Ho_mann[2], P Dechent[3], H Strasburger[1,4] ([1]Dept of Medical Psychology and Medical Sociology, Georg-August University of Göttingen, Germany; [2]Dept of Ophthalmology, Otto-von-Guericke University Magdeburg, Germany; [3]MR-Research in Neurology and Psychiatry, Georg-August University of Göttingen, Germany; [4]Institute for Medical Psychology, Ludwig-Maximilians University München, Germany; e-mail: shariful@math.uni-goettingen.de)

Due to the idiosyncratic folding of the visual cortex, the amplitude and polarity of the multifocal visual evoked potential (mfVEP) depend on stimulus location in the visual field. As a consequence, standard

time-synchronous averaging across di_erent stimulus locations leads to signal cancellation and degraded signal-to-noise ratio. We present a simple yet e_ective analysis technique for mfVEP data based on a template signal obtained in an iterative process from signals with equalized polarity. This template improves the S/N ratio by comparing individual signals from each location to the average. The relative amplitude and polarity for each stimulus patch corresponding to a visual field region are displayed in a dartboard-shaped activity map where activity is defined as Pearson's correlation between the local signal and the template. Borders of polarity reversal between areas of same polarity are displayed as colour change in these activity maps. To relate polarity reversals in mfVEP activity maps to the individual cortical folding, fMRI-based retinotopic mapping of area V1 was conducted with ring and wedge stimuli matched in size and texture to stimuli for the mfVEP acquisition with VerisScience. mfVEP activity maps and fMRI retinotopic maps are juxtaposed for the same subject to assess the impact of cortical folding on the mfVEP.

[HS and DAP are supported by the German Research Council (DFG), grant STR 354/7-1 to HS]

m

72

Temporo-parietal cortex encodes location of the self: joining fMRI with neuroscience robotics to study bodily self-consciousness

S Ionta[1], B Lenggenhager[1], M Mouthon[1], E Fornari[2], D Chapuis[3], R Gassert[3], O Blanke[1,4] ([1]Laboratory of Cognitive Neuroscience, Brain Mind Institute, École Polytechnique Fédérale de Lausanne (EPFL), Switzerland; [2]Dept of Radiology, CIBM-CHUV Unit, University of Lausanne, Switzerland; [3]Robotic Systems Laboratory, École Polytechnique Fédérale de Lausanne (EPFL), Switzerland; [4]Dept of Neurology, University Hospital (HUG), Geneva, Switzerland; e-mail: silvio.ionta@epfl.ch)

Neuroimaging of the self has focused on high-level mechanisms such as language, memory or imagery of the self and implicated widely distributed brain networks. Yet recent evidence suggests that lowlevel mechanisms such as multisensory and sensorimotor integration may play a fundamental role in self-related processing. In the present study we used visuotactile multisensory conflict, robotics, virtual reality, and fMRI to study such low-level mechanisms by experimentally inducing changes in self-location. Participants saw a video of a person's back (body) or an empty room (no-body) being stroked while a MR-compatible robotic device stroked their back. The latter tactile input was synchronous or asynchronous with respect to the seen stroking. Self-location was estimated behaviorally

confirming previous data that self-location only di_ered between the two body conditions. fMRI results showed a bilateral activation of the temporo-parietal cortex with a significantly higher BOLD signal increase in the synchronous/body condition with respect to the other conditions. Sensorimotor cortex and extrastriate-body-area were also activated.We argue that temporo-parietal activity reflects the experience of the conscious 'I' as embodied and localized within bodily space, compatible with clinical data in neurological patients with out-of-body experiences.

m

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Functional dissociations of multiple conflict-driven cognitive control networks

J Kim[1], C Kim[2], C Chung[1] ([1]Dept of Humanities & Social Sciences, KAIST, South Korea; [2]Dept of Anatomy and Neurobiology, University of Kentucky, USA; e-mail: miru@kaist.ac.kr)

Recent functional neuroimaging studies suggest that multiple conflict-driven cognitive control mechanisms are implemented in the brain depending on the level of processing; the dorsolateral prefrontal cortex (DLPFC) and the rostro-dorsal cingulate cortex (rdACC) for response conflict, and the dorsal portion of the premotor cortex (pre-PMd) and the caudal dACC (cdACC) for perceptual conflict (Egner et al, 2007 NeuroImage 35 940-948; Kim et al, in press Human Brain Mapping). A functional dissociation of DLPFC and rdACC has been further suggested for detecting and regulating response conflict, respectively. However, the functional roles of pre-PMd and cdACC remain unclear. In this study, we employed a conflict adjustment paradigm using a modified version of the Stroop task to measure post-conflict e_ects on those brain regions. Behavioral results demonstrated post-conflict adjustments in both perceptual and response conflict conditions. Imaging data showed a functional dissociation of pre-PMd and cdACC analogous to that of DLPFC and rdACC; cdACC activation was increased in the occurrence of perceptual conflict, but decreased in the subsequent perceptual conflict, whereas pre-PMd was associated with both the current and preceding perceptual conflicts. These findings suggest that cdACC is involved in detecting perceptual conflict, and pre-PMd plays a critical role in regulating perceptual conflict.

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m

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Neural correlates of preference to the visual art and the neuronal decoding

H Kawabata[1], T Sekiguchi[2] ([1]Dept of Psychology, Keio University, Japan; [2]Brain Science Group, Honda Research Institute Japan, Japan; e-mail: kawabata@flet.keio.ac.jp)

Using functional magnetic resonance imaging, we examined brain areas that are specifically engaging in preference decision (like/dislike) to the visual art (paintings), regardless of the category of painting (portrait/landscape). The results (N=18) showed the strongest activities in the superior orbito-frontal cortex for 'like' and in the motor cortex for 'dislike', regardless of the category of painting. We also found the strongest activities in viewing 'portrait' and 'landscape' were in the fusiform face area (FFA) and in the parahippocampal place area (PPA) respectively, regardless of the preference decision. Based on the results, we constructed neuronal decoders using a machine-learning method for each participant, which were trained and tested by BOLD signals of each participant to distinguish category (portrait/landscape) of paintings or preference (like/dislike) to paintings. The category-decoder and the preference-decoder distinguished two classes with mean accuracies of >90% and >75%, respectively. We also constructed 'a general category-decoder' which was trained by normalized BOLD data from 18 participants and tested by those from 1 participant. The decoder could distinguish 'portrait' from 'landscape' with mean accuracy of 73.1 %. This shows the stability of brain activity among participants and the possibility of decoding brain activity without training in this task.

m

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Brain activity related to within and between category object perception

B B Harry[1], M A Williams[2], C W Davis[1], J Kim[1] ([1]MARCS Auditory Laboratories, University of Western Sydney, Australia; [2]Macquarie Centre for Cognitive Science, Macquarie University, Australia; e-mail: b.harry@uws.edu.au)

Multi-voxel pattern analysis is used to investigate how distributed patterns of brain activity are related to di_erent perceptual and cognitive states. These techniques have typically been used to investigate the pattern of activity related to viewing objects from di_erent categories (eg faces and houses). The aim of the present study was to examine whether these analysis techniques are sensitive enough to detect activity related to viewing di_erent objects from the same category. This was explored by training pattern classifiers on brain imaging data collected while observers viewed images of faces expressing six di_erent emotions. So that classifier performance for within category distinctions could be compared against traditional between category distinctions, pattern classifiers were also trained on brain images collected while observers viewed images of houses. Consistent with previous studies, the results showed

that classifier accuracy was good for between category distinctions, particularly when the classifier was trained on data from the ventral temporal lobes. In contrast, classifier prediction accuracy was much lower for within category distinctions and also displayed much higher levels of intersubject variability across a range of ventral temporal and frontal brain regions. These results will be compared against multiregion classifier performance was well as standard univariate approaches.

POSTER SESSION: MOTION II

m

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Motion streaks in the brain: an fMRI study

D Apthorp[1], B Bahrami[2,3], D S Schwarzkopf[2,3], C Kaul[2,3], D Alais[1], G Rees[2,3] ([1]School of Psychology, University of Sydney, Australia; [2]Institute of Cognitive Neuroscience, University College London, UK; [3]Wellcome Dept of Imaging Neuroscience, University College London, UK; e-mail: deborah.apthorp@sydney.edu.au)

Temporal integration in the visual system causes fast-moving objects to generate static, oriented traces ('motion streaks'). While generally not seen, these might be used to help judge direction of motion (Geisler, 1999 Nature). Psychophysics and single-unit studies support this hypothesis, but no evidence from human brains has yet been provided. Here we use functional magnetic resonance imaging combined with univariate and multivariate pattern classification techniques to investigate the neural correlates of motion streaks. Observers viewed fast ('streaky') or slow-moving dot fields, moving at either 45 or 135 degrees, or static, oriented patterns (filtered noise) at the same orientations. Ten sessions, each with six blocks per session (randomized block design) gave ten blocks for each stimulus type. Univariate group analysis showed greater activation in early cortical areas when comparing fast to slow motion, but no increased activation in V5/MT+; the pattern of activity was similar to that seen when comparing static, oriented conditions to fixation rest. A multivariate pattern classifier trained on brain activity evoked by static, oriented patterns could successfully generalize to decoding brain activity evoked by fast but not slow motion sessions. These results suggest static, oriented 'streak' information is present in early visual cortex when viewing fast motion.

[Supported by the Australian Federation of University Women and the University of Sydney]

m

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Development of the preference for the moving human body

E Kitromilides-Salerio[1], A Chouchourelou[1], C Bidet-Ildei[2] ([1]Psychology Lab of Perception and Social Cognition, European University Cyprus, Cyprus; [2]CeRCA/MSHS, Université de Poitiers, France; e-mail: elenitsa.kitromilides@gmail.com)

Visual sensitivity to biological motion emerges very early in life. Babies depending on their age, express various competences in the perception of biological movements. Spontaneous visual preference for biological motion is observed at birth but factors explaining this preference are debated. Previous studies investigated the influence of translational displacement in the perception of point-light human walker in three-day-old human neonates. Using a standard visual preferential looking paradigm we found that human neonates prefer point-light figures with strong translational component regardless of the presence of human form in the display (Kitromilides-Salerio, 2009). These findings show that in human neonates the so-called preference for human locomotion could be linked, perhaps, to the translational displacement included in these movements. Here we examine for the first time the visual preference of adults for the same stimuli. Fourteen observers saw simultaneously two of our five point-light stimuli in random combinations: a translating walker, a translating rigid human, a translating scrambled walker, a random motion and a walker on treadmill. Our findings indicate a strong preference, both for the translating and the treadmill walkers ($F_{4,16}$=10.08, $p<0.001$). The discrepancy between neonates' and adults' findings suggests a possible role of social learning.

m

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Implied motion by Hokusai Manga activates the human motion-sensitive extrastriate visual cortex: an fMRI study of the impact of visual art

N Osaka[1], D Matsuyoshi[1], T Ikeda[1], M Osaka[2] ([1]Dept of Psychology, Kyoto University, Japan; [2]Dept of Psychology, Osaka University, Japan; e-mail: nosaka@bun.kyoto-u.ac.jp)

The recent human cognitive neuroscience has invited inference about the neurosensory events underlying the experience of visual arts involving implied motion.We report functional magnetic resonance imaging (fMRI) study demonstrating activation of the human extrastriate motion-sensitive cortex by static images involving implied motion because of instability. We used static line drawing cartoons of humans by Hokusai Katsushika (called 'Hokusai Manga'), an outstanding Japanese cartoonist as well as famous Ukiyoe artist. We found 'Hokusai Manga' with implied motion by depicting human bodies that are

engaged in challenging tonic posture significantly activated the motion-sensitive visual cortex including MT+ in the human extrastriate cortex, while an illustration that does not imply motion, for either humans or objects, did not activate these areas under the same tasks. We conclude that motion-sensitive extrastriate cortex would be a critical region for perception of implied motion in instability.

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m

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Segmentation by single and combined features involves di_erent contextual influences

L F Cuturi, C F Alberti, A Pavan, G Campana, C Casco (Dept of General Psychology, University of Padova, Italy; e-mail: luigi.cuturi@gmail.com)

Orientation discrimination of a texture line having orientation di_erent from that of static background lines is facilitated when the lines are aligned along their orientation axis and when their separation is small. The facilitation by alignment remains when motion is added to the target. However, when motion rather than orientation has to be judged, alignment reduces sensitivity (d.) regardless of whether target's orientation is the same as (iso-oriented) or di_erent from background elements. The inhibitory e_ect of alignment is confirmed when subjects have to discriminate motion direction of an iso-oriented target. Such inhibition by alignment is stronger when elements are close and may reflect a property of lateral interactions of motion detectors, since it is only present when observers have to judge target motion direction. Overall, our results indicate an opposite role of the lateral interactions that facilitate grouping of iso-oriented and collinear elements, in segmentation by orientation contrast and motion contrast. In other words, global grouping (i) facilitates discrimination of orientation contrast, indicating a global process, and (ii) inhibits both detection and discrimination of motion contrast, suggesting the presence of a local process.

m

80

Motion extrapolation in the central fovea

Z Shi[1], R Nijhawan[2] ([1]Allgemeine und Experimentelle Psychologie, Ludwig-Maximilians-University München (LMU), Germany; [2]Psychology Dept, University of Sussex, UK; e-mail: shi@psy.lmu.de)

Transmission delay of neural signals would introduce a spatial lag when an object moves across the visual field if it was not compensated. A visual predictive mechanism has been proposed to overcome such neural delay by extrapolating the position of the moving object. However, a forward shift is often absent at motion termination. A recent 'correction-for-extrapolation' hypothesis suggests that the absence of forward shifts arises from biased competition process due to signals representing failed predictions. To test this hypothesis, we examined the perceived shifts of the final and the initial position of a dim moving object in the rod-free central fovea. The forward shifts were observed in both conditions. In the second experiment, we compared the perceived position shifts of a blue moving object and a green

moving object. Given that the foveola is covered in a yellow macular pigment and absorbs blue light, the position signal of a blue object is weak or even absent. The forward shift at motion o_set was only found with the blue moving object. The results provide new evidence for the 'correction-for-extrapolation' hypothesis.

m

81

Local and remote interactions in visual motion processing for quick manual response

H Gomi, N Abekawa (Human and Information Science Lab, NTT Communication Science Labs, Japan; e-mail: gomi@idea.brl.ntt.co.jp)

The response normalization is known to be one of the important aspects in the early stage of visual motion processing. To investigate the normalization e_ect on the quick manual following response (MFR) induced by visual motion, we have evaluated MFR amplitudes elicited by stimuli having several vertical widths (0.5–10 deg) and a fixed horizontal length (80 deg) shown at di_erent locations (center, upper, or lower location on the frontal screen). Participants were asked to repeatedly produce reaching movements to the center of the screen with eyes fixating on the center location. MFR amplitude did not increase with vertical width of stimulus for the higher spatial frequency stimuli (0.2, 0.8 cpd), but progressively increased for the lower spatial frequency stimuli (0.02, 0.05 cpd). Additionally, by comparing the MFRs for di_erent stimulus locations, we found (1) a high sensitive feature of MFR on the visual center for each spatial frequency stimulus, (2) higher MFR sensitivity for visual motion on the bottom visual periphery with 0.05 cpd than for 0.2 cpd, and (3) almost linear integration e_ect of top and bottom stimuli for 0.2 and 0.05 cpd in spite of a stronger local normalization e_ect for 0.2 than for 0.05 cpd.

Poster session: Motion II

Wednesday

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m

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Age-related strategy changes in relative time-to-arrival judgments

K Landwehr, H Hecht, B Keshavarz (Allgemeine Experimentelle Psychologie, Universität Mainz, Germany; e-mail: landweh@uni-mainz.de)

151 children and 43 adults judged which of two cartoon birds would be the first to arrive at a common finish line. Objects moved unidirectionally along parallel trajectories, either at the same or di_erent speeds, and disappeared at di_erent distances from the goal. Overall, 9-10 year-old children performed as good as adults, but 4–5 and 6–8 year-olds erred significantly more often. On trials for which distance to goal at disappearance was a valid cue, 4–5 year-olds scored 80% correct, and no di_erences were seen between 6–10 year-olds and adults. On the opposite type of trials, where the trailing bird would win the race, only adults retained their level of performance, and all age-groups di_ered markedly. Findings suggest a gradual developmental transition from a distance-based to a time-based understanding of the task.

[Deutsche Forschungsgemeinschaft HE 2122/6-1: Kontaktzeitschätzung im Kontext (Heiko Hecht)]

m

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A tool for investigating orientation resolution in the human vision system

L Bowns, J S Beckett (Nottingham Visual Neuroscience, University of Nottingham, UK; e-mail: l.bowns@nottingham.ac.uk)

Bowns and Beckett (submitted Vision Research) describe an independent e_ect of spatial frequency on perceived motion of plaids. They showed that perceived motion direction shifts away from pattern motion direction towards the component motion direction at very low spatial frequencies (less than 1 cpd). This result was interpreted as revealing a broader tuning at these spatial frequencies. This in turn means that the necessary orientation and therefore direction could not be resolved su_ciently to compute pattern direction. Here we show that this e_ect can be increased or decreased by manipulating the ratio of the stimulus envelope to the spatial frequency of the components. This can also have an additional e_ect of broadening the spatial frequency tuning within the same range [augman, 1985 J Opt Soc Am A 2(7) 1160-1169]. The original e_ect of spatial frequency can be nulled, increased or decreased by manipulating this ratio and could be represented as a single number to understand individual di_erences or group di_erences.

m

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Flicker-induced motion with static patterns results from low-level processing

A L Beer, M W Greenlee (Institute for Experimental Psychology, University of Regensburg, Germany; e-mail: anton.beer@psychologie.uni-regensburg.de)

Flickering static patterns with elements of asymmetric luminance auch as bright and dark bars are perceived as moving. This type of illusory motion depends on the contrast of the pattern elements as well as on the flicker frequency. However, it is still unclear at what level of processing this illusory motion is generated. Therefore, we tested whether flicker-induced motion depends on monocular or binocular viewing. We found that illusory motion was perceived, if the dark and bright elements of the

flickering pattern were presented in the same eye. However, virtually no illusory motion was perceived, if bright and dark elements were presented in separate eyes. As interocular transfer is known to occur in the primary visual cortex, our finding that flicker-induced motion relies on monocular viewing suggests a generation at relatively early levels of visual processing. Flicker-induced motion was previously reported for translational motion. Therefore, we tested whether it also emerges for radial patterns. We found that flickering patterns of asymmetric luminance presented mirror-symmetric to the left and right visual field elicit radial illusory motion comparable to translational patterns. This finding suggests that flicker-induced motion does not depend on eye movements.
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m

85

Searching for cortical areas for a motion discrimination task

H Ashida (Graduate School of Letters, Kyoto University, Japan;
e-mail: ashida@psy.bun.kyoto-u.ac.jp)

Human MT+ responds to visual motion strongly, but conventional fMRI contrast does not reveal its tuning. fMRI adaptation has shown direction selectivity, but the interpretation remains controversial. Multivariate analysis can be useful in this respect. Especially, the searchlight method [Kriegeskorte et al, 2006 PNAS 103(10) 3863-3868] without pre-defined regions of interest might be informative when the substructures of MT+ have not been well understood. In this study, fMRI responses at around MT+ were measured (with Siemens Trio Tim, 3T) while the participants conducted a direction discrimination task for global rotation of noisy random dot stimuli. Brain Voyager 2.0 (Brain Innovation, The Netherlands) was used for the analysis. For one participant, univariate GLM revealed activation to the motion at

around the inferior temporal sulcus of each hemisphere (putative MT+). The multivariate searchlight also identified activation around it, indicating that the two motion directions are distinguishable there. Other areas in temporal and frontal areas showed activation, which might be related to judgment and response, but not around the calcarine sulcus (around V1). Results from another participant was similar but less clear. This pilot work has indicated that multivariate searchlight is indeed promising for investigating cortical motion processing.
[Supported by JSPS Grant-in-aid for scientific research (B20330149)]

m

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Red inhibits vection

T Seno, S Sunaga, H Ito (Faculty of Design, Kyushu University, Japan;
e-mail: senosann@yahoo.co.jp)

We investigated the e_ects of colours on vection induction. Expanding optical flows during one's forward self-motion were simulated by moving dots. The dots and the background were painted in equiluminant red and green. The individual isoluminance between red and green was measured in flicker photometry (20 Hz) on the whole screen. The optic-flow pattern was presented for 100 s, in which we measured latency, duration and subjective strength of vection. The subject's task was to keep pressing a button while they were feeling vection. The results indicate that the red background and also the red dots induced weaker vection than the green ones. There was no di_erence in vection strength between the green and grey background conditions. Thus red is an inhibitor of vection whereas green is not a facilitator nor an inhibitor. We further used a red or green sinusoidal grating matched by the minimum motion technique as a vection stimulus. It was assumed that these red and green gratings were equated in the e_ects concerning with e_ective contrast, perceived speed and visibility. Even with the grating stimuli, vection was weaker in the red condition. We concluded that red is an inhibitor of vection.
[Supported by the Ministry of Education, Culture, Sports, Science and Technology-Japan]

m

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E_ects of stimulus size and posture relative to the gravity axis on circular vection

S Tanahashi[1,2], H Ujike[2], K Ukai[1] ([1]School of Science and Engineering, Waseda University, Japan; [2]Institute for Human Science and Biomedical Engineering, Advanced Industrial Science and Technology, Japan; e-mail: zyuma1218@aoni.waseda.jp)

Results of our previous study suggest that circular vection is ine_ective when the body rotation axis simulated by optic flow coincides with the direction of gravity. Howard (1987), however, suggested the opposite result. We consider that the conflict of these studies was attributable to the immersiveness of visual stimulus, which can be manipulated by stimulus size. Therefore, we investigated the e_ect of sitimulus size to pitch vection when the observer's posture di_ered relative to gravity. In the experiment, random-dot stimulus was projected on a 160-cm-diameter dome . We measured the strength of pitch vection under eight combination conditions of the size of the stimulus (45, 90, 120, 180 deg in diameter) and posture (upright, and left-side-down) to investigate that hypothesis. The stimulus period in each trial was two minutes. During stimulus observation, the vection strength was measured using real-time evaluation with a six-point scale linear potentiometer. Two trials were conducted for each observer for

each condition. Results show that the pitch vection was significantly stronger and longer in the upright posture than in the left-side-down posture, irrespective of the stimulus size. Therefore, our hypothesis was rejected.

m

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Detection of changes: visual mismatch negativity (vMMN) to moving stimuli

N Kuldkepp[1,2], K Kreegipuu[1], R Näätänen[1,3], J Allik[1] ([1]Institute of Psychology, University of Tartu, Estonia; [2]Graduate School in Behavioural-, Social- and Health Sciences, University of Tartu, Estonia; [3]Cognitive Brain Research Unit, Dept of Psychology, University of Helsinki, Finland; e-mail: nele.kuldkepp@ut.ee)

MMN refers to the brain's automatic electrophysiological response to any change in sensory stimulation exceeding a certain threshold. vMMN was obtained to the di_erence in a direction of a regularly moving (200 ms motion, 600 ms pause) background (0.65 c/deg sine grating, luminance 0.13-128.2 cd/m^2, eccentricity 5.23 deg, velocity 1.6 deg/s). Observer's task was to react manually to the motion onset of a circular target area (sine grating similar to background, diameter 8.26 deg, velocity 0.6 deg/s, equal left-right probability). Attention was controlled by asking (i) to ignore the background ('ignore' condition); or (ii) to press left/right button when target and background were moving into the same or opposite directions ('attended' condition). In ERP results deviants evoked a more negative potential (peaking at 150–160 ms) than standards (ie, vMMN). In time-frequency analysis averaged CWTs (Morlet c=5, 1–20 Hz, 20 frequency steps) showed that mean component amplitude was significantly

higher (main e_ects, repeated measures ANOVA, $p<0.05$) in the attended condition compared to ignored condition in occipital pooled electrodes, and for processing deviants than standards in the central pooled electrodes. More prominent higher frequency for the attended condition activity occurred (>20 Hz) that speaks for more cognitive e_ort, top-down modulation, and awareness of stimuli.

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m

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Influence of accompanying tone on visually perceived speed

T Hanai, A Yoshino (Dept of Psychology, Meisei University, Japan; e-mail: 09mp015@stu.meisei-u.ac.jp)

We studied the influence of pitch of tones on perceived speed of motion. A black square on white background was moved at uniform velocity horizontally from left to right across the center of a 19-inch monitor in 2000 ms. In synchronization with the motion, a sound was played. We presented 15 acoustic conditions. We used 4×3, ie 12 conditions of the animated object moving with all permutations of pairs of the tones 220 Hz, 440 Hz, 880 Hz, and 1100 Hz exchanging after 1000 ms. And we also used three conditions: tones increasing from 220 to 1100 Hz, tones decreasing from 1100 to 220 Hz, and silence. The participants were allowed to describe their impressions freely, and they also judged the speed in the test. The participants were also asked to rate the perceived speed in 5-point scale. The speed of the apparent motion was evaluated to be accelerating when the associated tone gradually became higher in pitch, while it was evaluated to be decelerating when it gradually became lower. Also, presenting pure tones without pitch change, the motions accompanied with higher tones were evaluated to be faster than those with lower tones.

m

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Forward modeling counteracts surround suppression ahead of moving objects

N W Roach[1], P V McGraw[1], A Johnston[2] ([1]Visual Neuroscience Group, School of Psychology, University of Nottingham, UK; [2]Dept of Cognitive, Perceptual and Brain Sciences, University College London, UK; e-mail: nwr@psychology.nottingham.ac.uk)

Inhibitory lateral interactions accentuate discontinuities and are therefore ubiquitous in sensory systems. However a disadvantage of surround suppression is that it may also degrade the perception of objects moving into suppressed regions. Release of suppression in advance of a moving pattern could alleviate this problem. We investigated the detectability of target stimuli presented at the ends of a region containing a drifting inducer pattern. Here we show that suppression of the target stimulus is phase dependent at the leading but not at the trailing edge. By rotating the orientation of the inducing motion we show that sensory threshold is consistent with the detection of the sum of the sensory input and an internally generated predicted signal. The predictive model has a local spatial support and a local projection of _1 degree of visual angle and develops over the first 500 ms after stimulus onset. The e_ect remained when the inducer and target were presented to di_erent eyes, indicating a cortical locus for the predictive mechanism. These findings demonstrate that the visual system generates a forward prediction in a form that is compatible with sensory stimulation. The e_ect of this forward model is to eliminate surround suppression in the path of a moving object when the form of the moving object matches the prediction.

m

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Separating man from dog in the superior temporal sulcus
M D Kaiser[1], M Shi_rar[2], D Sugrue[1], C M Hudac[1], K A Pelphrey[1] ([1]Child Neuroscience Laboratory, Yale Child Study Center, Yale School of Medicine, USA; [2]Visual Cognition Laboratory, Rutgers University, Newark, USA; e-mail: martha.kaiser@yale.edu)
Researchers often refer to human motion as biological motion. However, biological motion does not exclusively suggest human motion. Typical adult observers demonstrate enhanced sensitivity to human movement compared to animal movement. Yet, the neural underpinnings of this e_ect are unknown. The right posterior superior temporal sulcus (pSTS) is a critical region for processing biological motion. Is the pSTS equally involved in the perception of human and animal movement? To date, no study has used fMRI to examine the visual perception of veridical human motion and animal motion. This study aims to clarify the neural mechanisms of the perception of biological motion. During an fMRI scan, typical adults viewed point-light displays of human, dog and tractor motions created from motion capture data. Participants viewed coherent or scrambled (control) stimuli. As predicted, observers exhibited significant activation of the right pSTS during the perception of human movement (coherent > scrambled) and animal movement (coherent > scrambled). Furthermore, the BOLD response along the right STS, dorsolateral prefrontal cortex and amygdala di_erentiated between the various types of

motion. This specificity of the neural response to human motion has implications for understanding development of the social brain and its role in disorders such as autism.

POSTER SESSION: MULTISENSORY PROCESSING

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A Bayesian model for a fully automated, virtual reality-based Rubber Hand Illusion
D Jimenez-Rezende[1,2], N Evans[1], O Blanke[1,3], W Gerstner[2] ([1]Laboratory of Cognitive Neuroscience, Brain Mind Institute, École Polytechnique Fédérale de Lausanne (EPFL), Switzerland; [2]Laboratory of Computational Neuroscience, Brain Mind Institute, École Polytechnique Fédérale de Lausanne (EPFL), Switzerland; [3]Dept of Neurology, University Hospital Geneva, Switzerland; e-mail: danilo.rezende@epfl.ch)
In the Rubber Hand Illusion (RHI) multisensory (visuotactile-proprioceptive) conflict leads to mislocalization of one's hand (Botvinick and Cohen, 1998 Nature 391 756). Despite detailed study, only conceptual models exist to explain the emergence of the RHI. On the other hand, simple Bayesian integration models (BIM) are known to account well for visuo-proprioceptive integration during other hand localization tasks (Deneve and Pouget, 2004 Journal of Physiology 98 249-258). Here we propose and experimentally test a three-sense BIM on the RHI. Participants (N=14) performed a right handlocalization task after being exposed (on a trial-by-trial basis) to di_erent visuotactile delays, visual hand positions, and proprioceptive hand positions. The participant's hand was obscured by a headmounted display presenting a virtual (visual) hand. Visuo-tactile stimulation was provided by vibration motors a_xed to the participant's right hand and animation of virtual motors on the virtual right hand. Analysis showed that visuo-proprioceptive integration is characterized by linear and non-linear phases; visuotactile delay modulates hand localization only in the latter. Standard visuo-proprioceptive BIMs fail to account for this non-linearity, in contrast to our proposed model that also incorporates the visuotactile delay e_ect. The present data emphasize the importance of automated multisensory stimulation with computational models to study the mechanisms of body ownership as tested in the RHI and other related illusions.

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How accurately is kinaesthetic information on hand position translated into visual space?
H Tanaka[1], C Worringham[2], G K Kerr[2] ([1]Health Science, Tokyo University of Agriculture and Technology, Japan; [2]Health and Biomedical Innovation, Queensland University of Technology, Australia; e-mail: tanahide@cc.tuat.ac.jp)
The present study psychophysically determined the accuracy of perception of time-varying hand locations without vision. Subjects' forearm was actively or passively extended on a robot arm in the horizontal plane at an approximately constant velocity of 130 deg/s. Direct vision of any arm movements was occluded with a flat screen. A visual probe stimulus was randomly presented on the screen at seven di_erent positions with respect to the tip of index finger during forearm extension. Subjects had to determine whether the probe appeared behind or advanced to where they felt the index finger tip to be. Constant error (CE) and sensitivity of the perception of hand position were estimated from the best fitting psychometric function to subject's judgments. There were no significant di_erences in CEs and sensitivities between the active and passive movement modes. CEs for the dynamic cases were not as large as those expected for static conditions. These results suggest that without vision, a_erent sensory information from stretched muscles and tendons plays a more important role in conscious perception of dynamic hand position than downstream information to prime movers. It is likely that the subjects could accurately translate such proprioceptive inflows on their hand positions into visual space.

[Supported by JSPS (#20500503)]

m

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Visual–haptic integration during tool use: perceived size from haptics is rescaled to take account of tool geometry

C Takahashi, S J Watt (School of Psychology, Bangor University, UK; e-mail: c.takahashi@bangor.ac.uk)

Humans are adept at using tools such as pliers, which systematically change the spatial relationships between an object's (visual) size and the hand opening. Previously, we showed that during tool use visual and haptic signals are integrated when they are caused by the same object, independent of conflicts between visual size and hand opening (Takahashi et al, 2009 VSS). This implies that haptic size estimates change when we use tools, taking into account the 'new' spatial relationships caused by the tool geometry. To examine this, participants explored virtual objects in haptics-only and vision-plus-haptics conditions using visually defined 'pliers', which either preserved a 1:1 mapping between visual size and

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hand opening, minified it, or magnified it. We measured perceived size using a matching paradigm. We varied haptic and visual sizes independently, to confirm that both modalities contributed to perceived size.We found that size estimates from haptics changed with tool type, independent of the opening of the hand, suggesting that haptic size estimates are rescaled during tool use. This rescaling was incomplete, however, resulting in biases in estimated size from haptics when using a tool. We present a Bayesian model of visual-haptic integration during tool use, which accounts for these findings.

[Supported by ORSAS and EPSRC]

m

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Time-varying nature of the ventriloquism e_ect

M Kobayashi, S Fujii, Y Iwaya, Y Suzuki (Research Institute of Electrical Communication, Tohoku University, Japan; e-mail: maori@ais.riec.tohoku.ac.jp)

The perception of the spatial location of an auditory stimulus can be captured by a spatially disparate visual stimulus, a phenomenon known as the ventriloquism e_ect. Many studies have shown temporal and spatial dependency of this illusion, but its temporal dynamics are not fully understood. In this study, we presented participants with a three-minute audiovisual stimuli, consisting of a pair of light and sound noise. The time series reported were analyzed as perceptual transitions. The spatial disparity between a noise and a light was either 0, 5, or 10 degrees. Ten participants were instructed to observe the audiovisual stimuli without any particular observation attitude, and to report their position consistency of stimuli by pushing one of two buttons, which indicated 'same' or 'di_erent' respectively. The participants were allowed to push a button whenever their perception changed. The results showed that (1) the mean total duration of the 'same location ' response increased as the disparities between noise and light decreased, (2) the percept switched during the stimulus presentation in all disparity condition after initial build-up of perception of 'same location', (3) the mean transition times varied depending on the disparity condition. These results show that the ventriloquism varies with observation time, suggesting that audiovisual spatial integration has a time-varying nature.

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E_ects of the alternation of sounds on the perceived direction of visual motion

W Teramoto[1,2], S Hidaka[3], Y Sugita[4], S Sakamoto[2], J Gyoba[1], Y Iwaya[2], Y Suzuki[2] ([1]Dept of Psychology, Tohoku University, Japan; [2]Research Institute of Electrical Communication, Tohoku University, Japan; [3]Dept of Psychology, College of Contemporary Psychology, Rikkyo University, Japan; [4]Neuroscience Research Institute, National Institute of Advanced Industrial Science and Technology, Japan; e-mail: teraw@ais.riec.tohoku.ac.jp)

The present study challenges the conventional belief that there is a spatial superiority of vision over hearing in motion perception. Visual apparent motion stimuli were presented in conjunction with a sound delivered alternately from two horizontally- or vertically-aligned loudspeakers. The direction of visual apparent motion was always perpendicular to the direction in which the sound alternated. The results showed that the perceived direction of visual motion could be changed into the alternate direction of sounds or the intermediate direction between the sound alternations and actual visual motion. The extent to which sound influenced the perceived direction of visual motion increased with increasing retinal eccentricity (from 2.5 to 40 deg). These findings suggest that the auditory and visual modalities can mutually influence motion processing and such interactions enable the brain to obtain the best estimates of external events.

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Short-term colour memory distorted by auditory information: crossmodal interaction

between colour and sound
T Nakamura, Y-P Gunji (Laboratory of Nonlinear Science, Kobe University, Japan;
e-mail: yellow198484@gmail.com)
Audio-chromatic crossmodal interactions are mostly discussed in the context of synesthesia phenomenon (colored-hearing synesthesia). However, previous works (Marks, 1978 American Journal of Psychology 87 173-188) showed that there are straightforward relationships between pitch, lightness and loudness in nonsynesthetes. These results indicated that nonsynesthetes can map similar sensory dimension with synesthetes. These relationships between colours and sounds, however, were the results via association and/or imagery of subjects. We here investigate how much auditory information takes part in perceived colors using short-term memory task with ten participants. Subjects memorized colour of circle (true value) under three di_erent environments (control, high pitch=2000 Hz, low pitch=200 Hz) and after short wait time (1.0 s) mechanically reported perceived colours using computerized palette of HSV

(hue=const) color-plane (saturation-axis, value-axis).We analyzed data distribution of gap distance from true values (saturation, brightness) to selected colours. Results showed significant e_ect of high-pitch (2000 Hz) ($p=0.017<0.05$) and low-pitch (200 Hz) ($p=0.0002<0.001$), and that frequency distribution of control and auditory stimuli were di_erent especially in large frequences (gap distance more than 10%). This suggests that perceived colours in this task are influenced by simultaneous auditory stimuli and additionally these e_ects occur especially in saturation component and indicates that there is comparatively robust correlation between visual (colour) and auditory information.

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The influence of handedness on visuo-haptic multisensory object processing
S Kim[1,2], T W James[1,2] ([1]Cognitive Science Program, Indiana University, USA; [2]Program in Neuroscience, Indiana University, USA; e-mail: suakim@indiana.edu)
There is considerable interest among vision scientists about how vision interacts with other sensory modalities. Recently, using fMRI, we have found evidence that visuo-haptic object processing may be lateralized to the left hemisphere regardless of which hand is used for the task; however, to date the studies have used only right-handed subjects. To generalize the investigation of visuo-haptic convergence beyond the study of right-handed subjects, in the current fMRI study, we investigated the neural substrates involved in bi-modal visuo-haptic object recognition in left-handed subjects using an additive-factors design. Tangible objects were explored under three conditions, viewing-only, touchingonly, or simultaneously viewing and touching the object. A whole-brain group-average statistical parametric mapping analysis found evidence of multisensory convergence in lateral-occipital, frontal, and parietal cortices, all in the right hemisphere, which is the opposite of the pattern usually observed with right-handed subjects. An analysis performed on each individual's data also showed that visuo-haptic object-selective regions-of-interest are more reliably found in the right hemisphere than the left in left-handed subjects, which is also the opposite of the pattern usually observed with right-handed subjects. Our findings show the first evidence for the influence of handedness on hemispheric asymmetry of multisensory object processing.
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m
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Maximum-likelihood analysis of visual-vestibular heading discrimination in the earth-horizontal plane
P R MacNeilage[1,2], C R Fetsch[3,2], D E Angelaki[2] ([1]Neurology, Ludwig-Maximilians University, Germany; [2]Anatomy & Neurobiology, Washington University in St. Louis, USA; [3]Physiology & Biophysics, University of Washington, USA; e-mail: p.macneilage@gmail.com)
Humans most often move in the earth-horizontal plane, so it is important to know how heading reliability changes for di_erent directions of movement in this plane and how this impacts visual-vestibular cue combination. Previous work has shown that heading estimates are less reliable for more eccentric heading directions. This change in reliability should lead to changes in cue weighting during multimodal heading estimation. Using a motion platform and attached visual display, we measured relative reliabilities of visual and vestibular estimates of azimuth and elevation for four heading eccentricities in the horizontal plane: 0, 30, 60, and 90 deg. Both visual and vestibular estimates of heading azimuth were less reliable at greater eccentricities. Vestibular estimates of heading elevation were also less reliable at greater eccentricities, but reliabilities of visual elevation estimates were less a_ected. Single-cue reliability measures were used to predict (1) the maximum-likelihood (ML) increase in reliability during multimodal heading estimation and (2) the visual and vestibular ML weights. On average, multimodal estimates were more reliable than single-cue, and close to the ML predictions. Observed weights were also close to the ML predictions, with one notable exception: visual weights were much lower than predicted for azimuth discrimination around straight ahead.
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Integration of dynamic force and visual information in 3D perception
H Umemura (Health Research Institute, National Institute of Advanced Industrial Science and Technology, Japan; e-mail: h.umemura@aist.go.jp)
In the present study, the e_ects of dynamic force information on visual 3D perception was investigated. In the experimental setting, a mirror was used to coincide with a cursor position in a simulated 3D space with the point of a stylus on a force-feedback device located under the mirror. In the experiments, subjects grasped the stylus and touched with the cursor the center of a rectangle in the visual display. Then the rectangle's surface stereoscopically protruded toward the subjects or dented. At the same

time, the stylus either moved toward the subjects, moved away, or did not move. These visual and force information were independently manipulated. Subjects were asked whether the rectangle visually protruded or dented. Results showed that when the stylus moved away, subjects were biased to perceive rectangles dented. This e_ect disappeared when the position of the cursor and the point of the stylus were not aligned, suggesting that the visual system tries to integrate the visual and force information if they spatially coincide. When the stylus moved toward the subjects or when the stylus did not move, subjects were biased to perceive rectangles as protruding. This might be because the visual system is originally biased to perceive surfaces as convex and indicates that the e_ect of the force information is not additive.
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How what we see a_ects what we taste
K Ohla, J Le Coutre, J Hudry (Nestlé Research Center, Lausanne, Switzerland; e-mail: Kathrin.Ohla@rdls.nestle.com)
Taste perception is influenced by many other sensations, eg texture, temperature, smell and visual appearance of a food, but also by expectations based on our previous experience and memory associated with a certain food or flavour. Priming activates associations in our memory impacting perception and decision-making outside conscious awareness. Here we used electrical neuroimaging analyses to investigate the e_ects of visual primes on taste perception. For this, images of food with varying reward-value (low-caloric vs high-caloric) and food-related attributes of positive, negative and neutral valence preceded a neutral taste stimulation. Behaviorally, taste stimuli were evaluated as most pleasant when preceded by positive food-related attributes and images of high-caloric food. At the brain level, we can link activations in the orbitofrontal cortex (OFC), the area known to participate in the hedonic evaluation of taste, to behavioral e_ects. Only positive (vs negative) attributes and high-caloric (vs low-caloric) images exhibit strong OFC activation and higher pleasantness scores. The findings suggest that visual information a_ects the processing of subsequently presented taste stimuli, in particular their hedonic evaluation, bearing important implications for the packaging and the labelling of food products as well as for strategies to optimize the nutritional value of foods.
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Crossmodal bodily incongruency modulates parietal and sensorimotor cortex: a virtual reality EEG study
P Halje[1], B Lenggenhager[1], O Blanke[1,2] ([1]Laboratory of Cognitive Neuroscience, École Polytechnique Fédérale de Lausanne (EPFL), Switzerland; [2]Dept of Neurology, Geneva University Hospital, Switzerland; e-mail: parhalje@gmail.com)
The interplay between our own body and the rest of the world is a basic aspect of bodily perception. Here we focused on the role of tactile crossmodal congruency for self-identification of a seen body (the full-body illusion, FBI). The participants were stroked on the back while they saw the back of a virtual body in front of them being stroked. We used a graded level of congruency between the tactile and the visual stroking of the back to study e_ects on self-identification and associated brain activity (EEG). Full parametric control of the crossmodal congruency was achieved with infrared motion tracking, which was applied to a virtual visual scene in real time. The participants were continuously making a subjective congruency judgment (indicated by button press). The EEG data revealed a gradual suppression of _- and _-band oscillations in the bilateral medial parietal cortex with increasing experimental visuotactile incongruency. A more anterior medial frontoparietal region was involved in the subjective judgment of congruency. This anatomical dissociation suggests that the two areas are two complementary nodes in a network engaged in matching visual and tactile events to bodily perception and self.
[Supported by the Swiss National Science Foundation]
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Cross-sensory calibration and integration in visually and acoustically deprived children
M Gori[1], G Sandini[1], A Chilosi[2], D C Burr[3,4] ([1]Robotics, Brain & Cognitive Sciences Dept,

Istituto Italiano di Tecnologia, Italy; [2]Scientific Institute Stella Maris, Pisa, Italy; [3]Dipartimento di Psicologia, Università degli Studi di Firenze, Italy; [4]Dept of Psychology, University of Western Australia, Perth, Australia; e-mail: monica.gori@iit.it)
Our recent results suggest that the development of multimodal integration of spatial information occurs late in childhood, around 8-10 years of age (Gori et al, 2008 Current Biology 18 694-698). Before integration is observed, either the haptic or visual system dominates, depending on the task: haptics for size and vision for orientation. We suggest that dominance is a side e_ect of sensory calibration. People with specific sensory deficits, such as congenital deafness or blindness, are ideal models to

investigate cross sensory calibration during development. We measured haptic orientation and size discrimination in congenitally blind or severely visually impaired children, and showed they had reduced haptic precision for orientation but not judgments (suggesting haptic calibration for size and visual calibration for orientation). Since audition is known to dominate temporal discriminations, we tested the role of auditory experience on temporal visual-auditory multisensory integration during development. We measured auditory, visual and auditory visual bisection in congenitally deaf children with successful cochlear implants. Preliminary results suggest that lack of early auditory experience retards audiovisual integration, support the idea of a late, experience-dependent development of visual-auditory integration, possibly driven by auditory calibration for temporal discrimination tasks.
[We thank the Istituto David Chiossone of Genova]

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Integration for visual and proprioceptive cues to hand position in development

M Nardini[1], K Begus[2], C Manning[3], D Mareschal[2] ([1]Institute of Ophthalmology, University College London, UK; [2]Centre for Brain and Cognitive Development, Birkbeck College, UK; [3]Dept of Experimental Psychology, University of Oxford, UK; e-mail: m.nardini@ucl.ac.uk)
Human adults integrate sensory estimates to reduce their variance. In recent studies, children up to 8 years old did not integrate visual estimates with those from other modalities to reduce variance when localizing objects or judging their size or orientation (Nardini et al, 2008 Current Biology 18 689-693; Gori et al, 2008 Current Biology 18 694-698). In the localization task, 4–8 year olds and adults had to recall locations based on visual landmarks and visual self-motion information after a short interval. The present study tested the same age groups using a simple table-top task with no memory demand (van Beers et al, 1999 J Neurophysiology 81 1355-1364). Children and adults attempted to point to a location signaled above a table-top by either vision, proprioception, or both, using the unseen hand beneath the table. Six-year-olds, 8-year-olds and adults were significantly less variable in their estimates given both vision and proprioception together vs either alone; 4-year-olds were not. This task shows earlier development of variance reduction by cross-modal integration than was previously reported. Di_erences with previous tasks include the absence of a memory demand or a two-alternative forced choice procedure. The possible impacts of these on children's performance will be considered.
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'Where is the sun?' The sun is 'up' in the eye of the beholder

M Barnett-Cowan[1], M O Ernst[2], H H Bültho_[1,3] ([1]Dept of Human Perception, Cognition and Action, Max Planck Institute for Biological Cybernetics, Tübingen, Germany; [2]Multisensory Perception and Action Lab, Max Planck Institute for Biological Cybernetics, Germany; [3]Dept of Brain and Cognitive Engineering, Korea University, South Korea;
e-mail: mbarnettcowan@gmail.com)
In environments where orientation is ambiguous, the visual system uses prior knowledge about lighting coming from above to recognize objects, reorient the body, and determine which way is up (where is the sun?). It has been shown that when observers are tilted to the side relative to gravity, the orientation of the light-from-above prior will change in a direction between the orientation of the body, gravity and the visual surround. The contribution of ocular torsion in this change of the light-from-above prior has been acknowledged but not specifically addressed. Here we test the hypothesis that when lighting direction is the only available visual orientation cue, change in orientation of the light-from-above prior is accounted for by ocular torsion. Observers made convex-concave judgments of a central shaded disk, flanked by three similarly-shaded and three oppositely-shaded disks. Lighting was tested every 15° in roll in the friendlily plane. Observers were tested when upright, supine, and tilted every 30° in role relative to gravity. Our results show that change of the light-from-above prior is well predicted from a sum of two sines; one consistent with predicted ocular torsion, the other consistent with an additional component varying with twice the frequency of body tilt.
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POSTER SESSION: READING

m

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Development of a ‘universal design’ font with blur tolerance

T Arai, Y Nakano, R Yamamoto (Research and Education Center for Natural Sciences, Keio University, Japan; e-mail: arait@psy.flet.keio.ac.jp)

An important factor that determines the ease with which textual information is conveyed is the font used, but a universal design must be envisaged assuming there are a variety of readers such as the disabled and the elderly. Thus, this study sought to develop and experimentally assess a universal design (UD) font that could be easily seen and read by readers with varied levels of visual acuity. Experiment 1 examined the legibility of the newly developed font by comparing it to the Ming typefaces and Gothic typefaces, which are typically used in Japan, and existing UD fonts. Experiment 2 examined font readability based on the principle of the Japanese version of the MNREAD reading acuity charts. Both experiments simulated low vision via a filter that attenuated high frequency components and observed how the fonts performed. Results revealed that the new font was more legible and readable than conventional fonts and that it was more easily discerned even by readers with low vision. In addition, modification of often misread characters and additional experimental assessment should lead to better legibility and visibility.

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m

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The relationship between character size preference and reading performance for people with low vision: Are their choices reasonable?

Y Nakano, T Arai, R Yamamoto (Research and Education Center for Natural Science, Keio University, Japan; e-mail: nakanoy@hc.cc.keio.ac.jp)

The aim of this study was to clarify the relationship between the character size preferred by people with low vision and their reading performance. This study examined whether or not a preferred character size (PCS) chosen by people with low vision would maximize their reading speed. First, interviews were conducted with regard to preferences for character sizes and large print. Then, visual acuity was measured with the logMAR near acuity charts and reading performance was measured with the MNREAD-J charts, and these results were compared in terms of the preferred character size. Participants were 78 high school students with low vision. Results revealed that 33.3% of participants achieved their maximum reading speed with their PCS at a viewing distance of 30 cm, 55.1% achieved that speed with their PCS at a distance of 20 cm, and 88.5% achieved that speed with their PCS at a distance of 10 cm. In actual settings involving reading, 70.5% of participants were able to achieve their maximum reading speed with a character size smaller than that preferred. Thus, people with low vision are able to reasonably select a character size based on preference alone, but their PCS tends to be larger than their critical print size.

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m

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Ultra-fast processing of printed words?

L A Bendahman, F Vitu, J Grainger (Laboratoire de Psychologie Cognitive, CNRS, Université de Provence, France; e-mail: l.bendahman@gmail.com)

Kirchner and Thorpe (2006 Vision Research 46 1762-1776) demonstrated that participants can accurately initiate a saccade to a scene containing an animal, presented along with a contralateral scene not containing an animal, in as little as 120 ms post-stimulus onset. We used the same forced-choice saccade paradigm with the same 200 ms gap between fixation o_set and stimulus onset in order to examine ultrafast identification of printed words. Five-letter words were presented along with 5-letter nonwords that could either be random consonant strings or pronounceable strings of letters (pseudowords). Words and nonwords were presented randomly left or right of fixation at 4° eccentricity (stimulus centre). Pilot work revealed very low levels of accuracy using similar stimulus durations as Kirchner and Thorpe. At 66 ms stimulus durations participants were at 70% accuracy overall, and the shortest accurate saccade latencies were 380 ms for words and consonant strings, and 431 ms for words and pseudowords. Saccade latencies in the control condition (where only one stimulus was presented) were only slightly longer than those found by Kirchner and Thorpe. These results suggest that the information used to rapidly access higher-level representations of visual objects is not available when processing printed words.

[Supported by ERC grant (#230313)]

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E_ects of ocular transverse chromatic aberration on peripheral word identification

S N Yang, Y C Tai, H Laukkanen, J E Sheedy (Vision Performance Institute, College of Optometry, Pacific University, USA; e-mail: shunnan.yang@pacificu.edu)

We previously showed that transverse chromatic aberration (TCA) significantly reduces the ability

to recognize nearfoveal letters. The present study examined whether TCA has a significant e_ect on peripheral word identification, and whether within-word orthographic facilitation interacts with TCA e_ect. Subjects were briefly presented a 6- to 7-letter word of high or low frequency. The center of the target word was 1, 2, 4, and 6 degrees to the left or right of a fixation point. Subject's eye position was monitored with an eye-tracker to ensure proper fixation. They were required to report the identity of the target word verbally as soon and accurately as possible. Target words were generated with horizontal color fringe to attenuate the TCA in the right periphery and exacerbate it in the left. Results show significant e_ect of color fringe on the latency and accuracy of recognizing low- but not high-frequency words. TCA e_ect was more salient in the right periphery and with lower-frequency words. Our results suggest that TCA significantly a_ects word identification in the right periphery, especially when withinword facilitation is weak. The asymmetry in TCA e_ect reflects the greater sensitivity to TCA in the right periphery, likely due to cortical magnification.
[Supported by Microsoft Corporation]

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Crowding e_ect in lexical and sublexical recognition
V Montani[1], A Facoetti[2], M Zorzi[2] ([1]Dept of Developmental Psychology and Socialization, University of Padova, Italy; [2]Dept of General Psychology, University of Padova, Italy; e-mail: veronica.montani@unipd.it)
We studied the crowding e_ect in a letter strings identification task by using progressive de-masking. In this degraded stimulus presentation procedures, the letter string emerges from the mask, with the advantage of providing response time as well as accuracy measurements. Stimuli were familiar words or pronounceable nonwords, and spacing between letters was manipulated. We used standard letter and decreased letter spacing (1.03×letter length). The letter string was centrally displayed and it subtended an angle of 5 deg (for the longest strings). Our results show that the identification of decreased spaced strings was slower than normally spaced strings (crowding e_ect). More importantly, decreasing distance between letters impaired more nonwords than words identification, showing a possible top-down modulation on crowding e_ect. Since sublexical identification and decoding are crucial for reading development, an increased crowding could be an important factor underling reading di_culties typically shown in dyslexic children.

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Measurement of stress and gaze points in tasks of detection of di_erences between closely similar images and sentences
E Watanabe[1], T Ozeki[2], T Kohama[3] ([1]Faculty of Intelligence and Informatcs, Konan University, Japan; [2]Faculty of Engineering, Fukuyama University, Japan; [3]Faculty of Biology-Oriented Science and Technology, Kinki University, Japan; e-mail: e_wata@konan-u.ac.jp)
When humans compares multiple images and/or sentences with others, they move gaze points in many regions for the detection of the di_erences among images and sentences. In this case, when the di_erences among them are little, these comparison tasks become di_cult for humans. Moreover, the stress of humans becomes high according to time. In this study, we discuss the relations between stress and gaze points of humans in the task of detection of di_erences between closely similar images and sentences. The gaze points can be recorded by a sunglasses camera embedded CCD device. This camera can detect the center position of gaze regions by a simple calibration procedure. On the other hand, the stress can be estimated based on the pulse rate, and SpO2 measured by a pulse oxymeter. From the comparison among the movements of the center of gaze regions, the pulse rate, and SpO2, we show the relationship between the stress of humans and the movements of the center of gaze regions for the above-mentioned tasks.

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Visual word recognition in unbalanced bilinguals with L1 Japanese and L2 English: the role of lexical knowledge of loan words written by katakana script of Japanese to read English words
T Ogawa (Faculty of Human Relations, Tokai Gakuin University, Japan; e-mail: ogawa@tokaigakuin-u.ac.jp)
The Japanese writing system uses three di_erent types of scripts: hiragana, katakana, and kanji scripts. Many words written in katakana script are loan words of foreign origin coming from English. When they

were introduced into Japanese from English, some words phonologically and/or semantically changed from an original English word. The native speakers of Japanese frequently use these loan words of foreign origin as Japanese words in everyday life. The present study investigates how lexical knowledge of katakana words influences visual word recognition of English words for native speakers of Japanese. In the experiment, lexical decision tasks using English words were conducted to examine the e_ects of word frequency and familiarity of words as written words of katakana script. Japanese undergraduate

students were divided into two groups in accordance with their relative levels of English proficiency. The results are discussed in terms of how lexical knowledge for loan words written by katakana scripts plays a role in reading English words and how phonological and semantic information of katakana words are represented in lexical memory.
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Eye movements while reading in regular orthographies: word length and word frequency e_ects in young German dyslexic and normally reading children

A N Sokolov[1], U Dürrwächter[2], J Reinhard[1], G Klosinski[2], S Trauzettel-Klosinski[1] ([1]Center for Ophthalmology, Low Vision Clinic and Research Lab, University of Tübingen, Germany; [2]Dept of Child and Adolescent Psychiatry, University of Tübingen, Germany; e-mail: alexander.sokolov@uni-tuebingen.de)

The di_culty of reading material, especially word length (WL) and word frequency (WF), a_ects eye movements in both normal and dyslexic readers of English, an orthographically irregular language. We varied WL and WF to examine eye-movement patterns in readers of German, an orthographically regular language, comparing the outcome with evidence available in other languages. Sixteen young German dyslexic children (mean age 9.5 years) and 16 age-matched controls read aloud four lists of ten unrelated words each. The list words di_ered orthogonally in WL and WF: high-frequency, short; high-frequency, long; low-frequency, short; low-frequency, long. Eye movements were recorded using a scanning laser ophthalmoscope (SLO). In dyslexic children, fixation durations and the number of saccades increased with both WL and WF. The percentage of regressions was only increased for low-frequency words. The most e_ects were qualitatively similar in the groups, but stronger in dyslexic children, pointing to a deficient higher-level, most likely phonological, processing. The results indicate that the di_culty of reading material modulates eye movements in young German children, and the nature of modulation depends on orthographic regularity of the language. The findings suggest that similar to Italian but unlike English readers, German children prefer indirect sublexical strategy of grapheme–phoneme conversion.

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Talk session: Motion

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TALK SESSION: MOTION

m Light stops play: motion at low luminance

R F Hess, A G Zaharia (McGill Vision Research, Dept Ophthalmology, McGill University, Canada; e-mail: robert.hess@mcgill.ca)

Objective: It is di_cult to play cricket or any other sport involving a fast moving ball at low light levels. This could be due to the fact that object visibility depends on light level or to a specific loss of motion detection per se at low light levels. Although a number of studies have addressed this issue in the past, none have adequately controlled for the detectability of motion stimuli at di_erent light levels. Method: We use global motion stimuli comprising spatial frequency bandpass elements whose detectability across scale could be measured and equated across light level. We measure central as well as peripheral global motion detection for a range of spatial frequencies (0.5–3 cpd and velocities (2–84°/s) Result: Although contrast detection thresholds for global motion discrimination do vary with luminance in the characteristic way, motion coherence thresholds do not. This is true even at low velocities (2°/s) Conclusion: Coherence thresholds for global motion are invariant with light levels over a very large spatiotemporal range. What stops play is not our inability to encode motion but our inability to see what is moving.
[Supported by NSERC (#46528-06)]

m E_ects of contrast and spatial frequency on the perceived speed of simple and complex gratings

K R Brooks[1], T Morris[1], P Thompson[2] ([1]Dept of Psychology, Macquarie University, Australia; [2]Dept of Psychology, University of York, UK; e-mail: kevin.brooks@mq.edu.au)

Manipulations of the contrast or spatial frequency (SF) of a simple sine-wave grating pattern can influence its perceived speed (Thompson et al, 2006 Vision Research 46 782-786; Smith and Edgar, 1990 Vision Research 30 1467-1474). Many MT cells change speed preference with SF, yet behave in a more genuinely speed-tuned fashion for stimuli with higher contrast or multiple SF components (Priebe et al, 2003 Journal of Neuroscience 23 5650-5661). We measured perceived speed for complex (2 component) gratings and their isolated components at various SFs, temporal frequencies (TFs) and contrasts using a yes–no speed discrimination paradigm. Foveal 'standard'/'match' stimuli were sequentially presented. The standard grating (simple or compound; low or high contrast) remained at constant speed (3 deg/s), while a staircase manipulated the speed of the match (broadband noise; intermediate contrast). At this constant speed, increasing average SF (and hence TF) increases perceived speeds for simple and, to a lesser extent, complex gratings. Likewise, increasing contrast increased perceived speeds for simple and, to a lesser extent, complex gratings. The average of the perceived speed of components predicted the perceived speed of the compound stimulus with moderate success. Implications for models of speed processing will be discussed.

m What causes the facing-the-viewer bias in biological motion?
N F Troje[1,2], M McAdam[1] ([1]Dept of Psychology, Queen's University, Canada; [2]School of Computing, Queen's University, Canada; e-mail: troje@queensu.ca)
Point-light walkers and stick-figures rendered orthographically and without self-occlusion do not contain any information as to their depth. For instance, a frontoparallel projection could depict a walker from the front or from the back. Nevertheless, observers show a strong bias towards seeing the walker as facing the viewer (FTV, Vanrie and Verfaille, 2006 Perception & Psychophysics 68 601-612). A related stimulus, the silhouette of a stationary human figure (Kayahara, 2003, http://www.procreo.jp) does not seem to show a FTV bias. We created stimuli representing gradual transitions from the silhouette figure to a stick-figure. Rotating them slowly about a vertical axis, we asked observers to indicate if they saw clockwise or counterclockwise rotation. Measuring frequency and angle of perceptual reversals we derived a unbiased measure of the FTV bias. Results reveal that the FTV bias is not due to the presence or absence of walking behaviour and does not depend on the posture of the figure. It is a direct consequence of transitioning from a silhouette to the stick figure. The FTV bias can be explained assuming that the visual system perceives the marks (dots or sticks) to be on the surface of an opaque body and that it assumes a higher probability of them being on the front than on the back.
[Supported by NSERC, CFI, CIfAR]
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m Optimal sensory adaptation without prior representation of the environment
S Gepshtein[1,2], P Jurica[2], I Tyukin[3], C van Leeuwen[2], T D Albright[1] ([1]Vision Center Laboratory, Salk Institute for Biological Studies, USA; [2]Brain Science Institute, RIKEN, Japan; [3]Dept of Mathematics, University of Leicester, UK; e-mail: sergei@salk.edu)
We proposed that human spatiotemporal contrast sensitivity function (Kelly, 1979 JOSA 69 1340-1349) manifests optimal allocation of visual resources [Gepshtein et al, 2007 Journal of Vision 7(8):8, 1-18]. This view explains some previously puzzling results in motion adaptation. The local gains and losses of contrast sensitivity observed at the adapting conditions, and away from the adapting conditions, are explained by a global change in contrast sensitivity: a shift of Kelly's sensitivity function in the stimulus space. This view is supported by psychophysical measurements of contrast sensitivity under changes in the statistics of stimulation (Gepshtein et al, 2009 Frontiers in Systems Neuroscience doi:10.3389/conf.neuro.06.2009.03.336). Here we show that the optimal changes in the distribution of contrast sensitivity do not require a representation of stimulus statistics. We model a population of motion-sensitive cells, each tuned to spatial frequency, temporal frequency, and speed of stimuli. The tuning of each cell fluctuates, independent of other cells, the amount of fluctuation proportional to uncertainty of measurement by the individual cells. We find that the random and independent changes of cell tuning add up to the globally-optimal changes of contrast sensitivity observed in psychophysical studies of motion adaptation. In other words, the globally-optimal and adaptive behavior is emergent.
[Supported by The Swartz Foundation (SG)]

m Comparison of fMRI and ERP responses to global motion in adults
J Wattam-Bell[1], S Moazzami[1], S Gray[1], D Birtles[1,2], J Atkinson[1], O Braddick[2] ([1]Division of Psychology and Language Sciences, University College London, UK; [2]Dept of Experimental Psychology, University of Oxford, UK; e-mail: j.wattam-bell@ucl.ac.uk)
Steady-state ERPs to global motion stimuli—random-dot patterns (RDPs) that alternate between coherent and incoherent motion—show a midline focus, consistent with sources near V1. However, many fMRI studies have shown that global motion mainly activates lateral areas, with little or no V1 involvement. In an attempt to resolve this contradiction, we compared global motion fMRI with source-analysed transient ERPs. The stimuli consisted of 15 s 'o_' blocks, (RDP motion remained incoherent), alternating with 15 s 'on' blocks, (the RDP switched between incoherent and coherent motion every 1.2–1.5 s). The fMRI response was derived from the di_erence in BOLD signal between 'on' and 'o_' blocks, and the areas activated (MT/V5+, KO & V6) conformed to previous fMRI studies. The global ERP, based on the di_erential response to coherence onset and o_set within the 'on' blocks, showed a small MT/V5+ activation at 70 ms, followed by a larger V1/V2 response at 220 ms. The motion ERP is dominated by V1/V2 responses which are not apparent in fMRI with the same stimuli. The reason for this discrepancy remains unclear; one possibility, currently being explored, is that it is a consequence of the di_erent e_ective timescales of the fMRI and ERP measurements.
[Supported by UK Medical Research Council grant number G0601007]

m Adaptation of speed and duration of biological motion stimuli
R Arrighi[1,2], S Orsi[1], D C Burr[1,3] ([1]Psychology Dept, University of Florence, Italy; [2]Vision Laboratory, IRCCS Fondazione Stella Maris, Italy; [3]Neuroscience Institute, National Research Council, Italy; e-mail: roberto.arrighi@gmail.com)
Sustained exposure to a moving stimulus reduces the apparent speed of a pattern displayed in the same region. We studied the e_ect of adaptation to point-light displays of human walkers and runners. Adapting to a runner exposed for about 40 s reduced the perceived speed of a walker displayed to the same region by up to 40%. Smaller, but robust reduction of perceived speed was also achieved with many forms of biological motion adapters, where either the running direction or the running sequence was

reversed, indicating a lack of selectivity for such dimensions. However, adapting to nonbiological motion patterns such as drifting gratings or translating runners had no e_ect on perceived speed, suggesting that mechanisms specific to biological motion were adapted. We also measured the e_ect of adaptation on perceived duration of biological motion. Adaptation to the runner reduced considerably the apparent duration of a briefly presented walker. However, when the probe was matched for apparent speed duration estimations were completely una_ected by adaptation (unlike simple grating stimuli), suggesting that di_erent mechanisms for time processing may be involved for di_erent kind of visual stimuli.
[Supported by EU-project STANIB (FP7 ERC)]

m Do high-contrast skin patterns support motion camouflage?

J M Zanker[1], M J How[2] ([1]Dept of Psychology, Royal Holloway University of London, UK; [2]Sensory Neurobiology Group, University of Queensland, Australia; e-mail: j.zanker@rhul.ac.uk)

Many animals, ranging from insects, fish and snakes to tigers and zebras, sport high-contrast skin patterns that make them highly visible. Evolutionary biologists and visual ecologists have been puzzled by the potential adaptive value of such a conspicuous appearance, and it has been speculated about a wide range of mechanisms that could add fitness benefits, including individual identification, thermoregulation, protection against parasites, or predator avoidance. To investigate the possible 'dazzle' e_ect of such patterns, which has been suggested as a powerful means of camouflage, we used computer simulations of a biologically motivated motion detection algorithm (the '2DMD' model) to analyse the motion signals generated by di_erent areas on particular animals' bodies, such as the zebra or the common adder. These distributions of motion signals resemble those perceived by a predator observing their moving prey, or those produced by predator eye movements such as saccades. Simple displacements of pictures of these animals generate strong but incoherent patterns of local motion signals, varying with the tuning parameters of the motion detectors, which lead to considerable ambiguities about the movement direction of the whole animal, and which would make it di_cult to track such targets on basis of motion information.

m Psychophysical tests of the motion energy model

G Mather, K Challinor (School of Psychology, University of Sussex, UK; e-mail: g.mather@sussex.ac.uk)

Since its introduction 25 years ago, the motion energy model (Adelson and Bergen, 1985 Journal of the Optical Society of America A 2 284-299) has become the standard theoretical scheme for low-level motion sensors in human vision. Translational motion is represented as an oriented pattern in x-t space, and is encoded using spatiotemporally oriented receptive fields (filters which are combinations of spatial and temporal impulse responses). We found that the output of the model is qualitatively consistent with a range of psychophysical data on motion perception. We also used two-stroke apparent motion (2SAM) to test some details of the model's implementation in human vision. In 2SAM, repeated presentation of a two-frame pattern displacement followed by a uniform interstimulus interval (ISI) creates an impression of continuous forward motion (Mather and Challinor, 2009 Journal of Vision 9 1-6). We investigated whether the model can explain the dependence of 2SAM on ISI duration and luminance. We found that (i) dependence on ISI duration reflects the centre temporal frequency of the underlying biphasic temporal filters; (ii) dependence on ISI luminance reflects the parameters of the underlying spatial Gabor filters.
[Supported by the Wellcome Trust (WT082816MA)]

TALK SESSION: MULTISTABILITY, RIVALRY

m Ambiguous, high-contrast and unambiguous, low-contrast primes induce a common perceptual memory

A Pastukhov, K Ludwig, J Braun (Cognitive Biology, Otto-von-Guericke University Magdeburg, Germany; e-mail: pastukhov.alexander@gmail.com)

In multi-stable perception, past dominance of one appearance facilitates renewed dominance of the same appearance, especially after long (>10 s) blank intervals [Pastukhov et al, 2008 J Vis 8(13):7, 1-14]. After similarly long blank intervals, a low-contrast prime facilitates the subsequent detection of the same stimulus [Tanaka and Sagi, 1998 PNAS 92(21) 12729-12733]. Might these e_ects of high-contrast (HC) primes on multi-stable appearance and of low-contrast (LC) primes on threshold perception be related? We manipulated the ambiguity of HC primes by varying the strength of the perceptually suppressed parts. The priming e_ect of HC stimuli (binocular rivalry, Necker cube, kinetic-depth e_ect) depended on their ambiguity and disappeared for unambiguous HC primes. Intriguingly, low contrast restored the e_ect of an unambiguous prime on multi-stable appearance: indeed, priming strength was inversely related to contrast. In a separate series of experiments, we found that ambiguous HC primes facilitated threshold perception, just as unambiguous LC primes did. In summary, both ambiguous HC and unambiguous LC stimuli induce a novel type of perceptual memory (which is neither iconic nor visual short-term memory) and which in turn facilitates both multistable dominance and threshold perception. Surprisingly, this type of memory seems to play a pervasive role in visual perception.

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m Shifting attention makes you flip: exogenous visual attention triggers perceptual alternations during binocular rivalry

C L E Pa_en, S van der Stigchel (Experimental Psychology & Helmholtz Institute, Utrecht University, The Netherlands; e-mail: c.l.e.pa_en@uu.nl)

During binocular rivalry, perception alternates between dissimilar images presented dichoptically. It has been argued that binocular rivalry and visual attention are closely linked, but strong evidence is missing. Here we investigate this claim by asking whether the timing of perceptual alternations is a_ected by spatial cueing. In two experiments, rivalry was instigated at two locations, left and right of fixation. Shortly after onset of a trial, a cue was presented at one of these locations or at fixation. In Experiment 1, observers responded whether a target was presented to the left or right location. In Experiment 2, observers reported perceptual alternations for both locations. Experiment 1 produced classical cueing results: shorter reactiontimes to cue-valid than to cue-invalid targets. Importantly, cueing a_ected the timing of perceptual alternations in Experiment 2—alternations occurred earlier and more frequent at cued versus uncued locations. The results show a tight link between the dynamics of visual attention and the occurrence of perceptual alternations during binocular rivalry. We suggest that cueing a location where rival images are presented leads to a transient increase in the e_ective contrast of these rival images. This transient increase in e_ective contrast increases the probability of an alternation at that location.

m The e_ect of transient monocular deprivation on binocular rivalry

C Lunghi[1,2], D C Burr[1,2], M C Morrone[1,3] ([1]Dept of Psychology, Università degli Studi di Firenze, Italy; [2]Neuroscience Institute, CNR - Pisa, Italy; [3]Dept of Physiological Sciences, University of Pisa, Italy; e-mail: claudia.lunghi@in.cnr.it)

It is well known that abnormal visual experience such as monocular deprivation (MD) produces dramatic e_ects on the developing mammalian visual cortex. We used binocular rivalry to investigate the e_ect of MD on adult humans. We measured the mean phase duration of rivalrous visual stimuli (orthogonal gratings, contrast 0.75, SF 3 cpd) presented separately to the two eyes through Ferro-magnetic shutter goggles, after a period of MD in which subjects wore a translucent patch on one eye for 150 minutes. On removal of the patch, the visual stimulus presented to the previously patched eye dominated rivalrous perception. MD was most e_ective when the preferred eye was patched, with mean duration of the deprived eye 2.7 times that of the non-deprived eye; compared with a factor of 1.6 for patching the non-preferred eye. The maximum e_ect was observed during the first 3 minutes after the removal of the eye-patch and decayed within 15 minutes of re-exposure to normal visual experience. Preliminary results also suggest that patching causes a decrement in contrast sensitivity of the non-patched eye. Our results reveal a form of experience-dependent plasticity in the adult human visual cortex, that at first sight is di_erent from that reported in animals (under somewhat di_erent conditions).

m Binocular rivalry persists at low contrasts; monocular rivalry is enhanced at low contrasts

R P O'Shea[1,2] ([1]Psychology, School of Health and Human Sciences, Southern Cross University, Australia; [2]Dept of Psychology, University of Otago, New Zealand; e-mail: robert.oshea@scu.edu.au)

Binocular rivalry occurs when we view very di_erent stimuli with each eye. Instead of perceiving a stable combination of both stimuli, we perceive one stimulus at a time, alternating irregularly. A similar sort of rivalry, monocular rivalry, occurs when the same stimuli are presented to both eyes simultaneously, although the changes in visibility are much weaker. I studied the e_ects of contrast on rivalry by measuring contrast thresholds for individual observers, then presenting vertical and horizontal rival gratings at contrasts of 1 to 64 times contrast threshold. Observers recorded when each grating was visible and also when they saw both stimuli together in one-minute trials. I found that binocular rivalry occurs at all contrasts but that it is slower at lower contrasts. Monocular rivalry also occurs at all contrasts but it is particularly marked at lower contrasts and slower at higher contrasts. Both sorts of rivalry at low contrasts have a gamma-like distribution of periods of dominance. I conclude that the processes responsible for rivalry do operate with low-contrast inputs. For binocular rivalry, high contrasts give good evidence of two objects impossibly at the same location in the visual field. For monocular rivalry, high contrasts give good evidence of a single object, namely a grid.

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Talk session: Multistability, rivalry

m Fine-grained temporal analysis of the initiation of binocular rivalry

U Roeber[1,2] ([1]Institute for Psychology I, University of Leipzig, Germany; [2]School of Medical Sciences, University of Sydney, Australia; e-mail: urte@uni-leipzig.de)

I explored the neural mechanisms underlying visual processing of brief stimuli that were either the same in the two eyes or di_ered in orientation. To get at the neural mechanisms, I measured visual evoked potentials (VEPs) to 200-ms sine-wave gratings di_ering in orientation between the eyes from 0° to 90°. I used two di_erent grating contrasts. High-contrast gratings yielded larger visual evoked potential (VEP) amplitudes than low-contrast gratings, confirming that neural responses depend on salience. The first VEP component (100 ms) was larger when the orientations were the same than when they were di_erent whereas it was the opposite for the second component (160 ms). This suggests that the first

component reflects binocular summation and the second reflects binocular rivalry. When grating contrast was low, the size of the second component was monotonically related to the orientation di_erence. This fine-grained temporal analysis suggests that the rivalry mechanism is sensitive to orientation di_erences at low contrasts but saturates at high contrasts.
[Supported by German Research Foundation (DFG-project RO3601/1-2)]

m Right parietal cortex biases perceptual reversals for ambiguous figures and binocular rivalry

J Britz[1], M A Pitts[2], T Landis[3], C M Michel[1] ([1]Dept of Fundamental Neuroscience, University of Geneva, Switzerland; [2]Dept of Neuroscience, University of California, San Diego, USA; [3]Dept of Neurology, University Hospital of Geneva, Switzerland; e-mail: juliane.britz@unige.ch)

We assessed perceptual alternations in multi-stable perception as a function of the prestimulus brain state. We hypothesized that the global brain state indexed by the EEG topography at the time of stimulus arrival can dissociate perceptual reversals from nonreversals. In the first study, we used an intermittent presentation of a Necker cube and recorded the EEG from 256 channels. We extracted the EEG topography at the time of stimulus arrival and identified two topographies that doubly dissociated perceptual reversals from nonreversals. Statistical parametric mapping of their concomitant intracranial generators revealed increased activity in right inferior parietal cortex. This area appears to bias perceptual reversals before stimulus arrival. In the second study, we likewise assessed perceptual reversals during binocular rivalry, also with an intermittent presentation. We again identified two EEG topographies before stimulus arrival that doubly dissociated perceptual reversals from nonreversals. Their concomitant intracranial generators showed increased activity in virtually the same area in right inferior parietal cortex and decreased activity in bilateral lateral occipital and inferior temporal areas. Although perceptual alternations elicited by ambiguous figures and binocular rivalry arise from fundamentally di_erent processes, we can show that neural events preceding these reversals are similar and arise in the same area.

m Reflexes as objective measure of rivalry dynamics

M Naber, W Einhäuser (AG Neurophysics, Philipps-Universität Marburg, Germany; e-mail: marnixnaber@gmail.com)

During perceptual rivalry, a constant stimulus allows multiple equally likely interpretations, among which perception alternates over time. Typically observers report the dominant percept by means of an overt action, such as a button press. It is, however, unclear, whether the action itself could a_ect visual awareness and thus confound rivalry dynamics. Here we investigate the use of reflexive behaviors, such as the pupillary reflex or optokinetic nystagmus, as objective indicators for the dominant percept. Remarkably, pupil diameter strongly depends on the perceived luminance and contrast of the dominant percept, rather than on the stimulus´ physical properties. In addition to the prediction of the timing of perceptual alternations, pupil diameter also serves to indicate the dominant percept. This technique can be utilized for any type of rivalrous stimuli that allow independent luminance or contrast manipulations between percepts. Beyond the usefulness of reflexive behaviors to circumvent the potential confounds of overt action, reflexes also provide a continuous measure of an internal state and thus more information on perceptual dynamics than the timing of alternations alone.
[Supported by DFG (EI 852/1 and GRK 885)]

Talk session: Face perception
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m Your pupil knows things earlier than you

M Fahle[1,2], T Stemmler[1], K Spang[1] ([1]Dept of Human Neurobiology, University of Bremen, Germany; [2]Wellcome Laboratories, City University, London, UK; e-mail: mfahle@uni-bremen.de)

We developed a new method to use the pupil response as an objective measure of binocular rivalry by presenting conflicting stimuli of di_erent brightness to the two eyes and employed it to determine the perceptual transition during rivalry. Stimuli appeared on a monitor equipped with circular polarizing filters, with half the pixels being polarized clockwise and the other half anticlockwise. One stimulus consisted of a horizontal, the other one of a vertical grating, with di_erent mean luminances and contrasts. Observers looked at these stimuli through matched polarizing goggles. Pupil size was calculated by software developed in-house. Observers indicated transitions in perceived grating orientation (rivalry) by pressing the appropriate one of two push-buttons. In a control experiment, rivalry was simulated but flipping stimulus orientation by 90 deg at irregular intervals. We find a clear pupil response when the percept changes between the rivalrous stimuli — as well as when the stimulus changes physically in the control experiment. While the pupil response starts only marginally earlier than the button press for the physical stimulus transitions, it precedes the button press by more than 500 ms for the rivalrous transitions. These results suggest that the pupils know about the pending rivalrous transition before the observer does — or don't they?
[Supported by DFG Fa 119/17-1]

TALK SESSION: FACE PERCEPTION

m Stable barcode structures in the spatial scale analysis of images of human faces

R J Watt[1], S C Dakin[2], V Go_aux[3] ([1]Dept of Psychology, University of Stirling, UK; [2]Institute of

Ophthalmology, University College London, UK; [3]Faculty of Psychology and Neuroscience, University of Maastricht, The Netherlands; e-mail: r.j.watt42@gmail.com)
Dakin and Watt [2009 Journal of Vision 9(4):2 1-10] have reported the importance of horizontal image structures for perceiving faces. They also reported that the horizontal information in images of faces tended to fall into barcode style patterns: closely stacked and aligned vertical arrays of horizontal bars. We extend this research by showing that the barcodes in face tend to fall into two distinct bands of spatial scale that can be readily identified from the image. There is one coarse scale barcode that tends to cover the whole face and three fine scale barcodes, one each for the two eye regions and one for the mouth region. The fine scale barcodes are each readily located from the coarse scale barcode. Examination of video sequences of people talking shows that the barcodes at the two scales behave di_erently: the coarse scale barcode is relatively unvarying in time, whereas the finer scale barcodes change their form to reflect the facial actions of the speaker. We show that a simple parameterization of these barcodes can contain a wide range of information about the face.
[Supported by Leverhulme Research Fellowship to RJW]

m Faces are represented relative to race-specific norms

R Armann[1], L Je_ery[2], A J Calder[3], I Bülthoff[1], G Rhodes[2] ([1]Dept of Human Perception, Cognition and Action, Max Planck Institute for Biological Cybernetics, Tübingen, Germany; [2]School of Psychology, University of Western Australia, Australia; [3]MRC Cognition and Brain Sciences Unit, Cambridge, UK; e-mail: regine.armann@tuebingen.mpg.de)
Recent models of face perception often adopt a framework in which faces are represented as points in a multidimensional space, relative to the average face that serves as a norm. Faces share many visual properties and could be encoded in one face space against one single norm. However, certain face properties may result in grouping of similar faces. How faces might be 'subclassified' in face space remains thus to be determined. We studied the processing of faces of di_erent races, using high-level aftere_ects, where exposure to one face systematically distorts the perception of a subsequently viewed face towards the 'opposite' identity in face space. We measured identity aftere_ects for adapt-test pairs that were opposite race-specific (Asian and Caucasian) averages and pairs that were opposite a 'generic' average (both races morphed together). Aftere_ects were larger for race-specific than for generic anti-faces. Since adapt-test pairs that lie opposite each other in face space generate larger aftere_ects than non-opposite test pairs, these results suggest that Asian and Caucasian faces are coded using race-specific norms. Moreover, identification (at low identity strength) of the target faces was

easier around the race-specific norms than around the generic norm, indicating that norms also have a functional role in face processing.
[Supported by the German Academic Exchange Service (DAAD) and the MPI for Biol. Cybernetics]

m Scan patterns reflect facial attractiveness judgments

D Bombari, F W Mast (Dept of Psychology, University of Bern, Switzerland; e-mail: dario.bombari@psy.unibe.ch)
Facial beauty has often been studied by using subjective measures such as judgments of attractiveness. In this study, we combined judgments of attractiveness with the analysis of eye movements in order to study processing strategies in high and low attractive faces. We found that high attractive faces evoked a more configural scanpath compared to low attractive faces. This suggests that high attractiveness is processed by integrating the information from di_erent face regions, thus enhancing the perception of standards of facial beauty that rely on proportions. Moreover, participants performed a higher number of fixations and therefore showed higher visual interest in attractive faces. Finally, participants looked preferably at the eye region and the poser's left hemiface when the faces were attractive. Our findings suggest that scan patterns can be considered as a signature of beauty: as soon as an attractive face is detected, a specific eye movement strategy is elicited to confirm the initial evaluation.

m Recognizing one's own face in visual-proprioceptive integration

Y Tanaka[1,2], M Hashiguchi[3], T Kawahara[3] ([1]Miki Optical Institute, Japan; [2]Neurocreative Laboratory, Japan; [3]Human Information System Laboratory, Kanazawa Institute of Technology, Japan; e-mail: yt249136@gmail.com)
Recent study demonstrates that perception of self is based on information of visual-proprioceptive integration (Shimada et al, 2005 NeuroImage 24 1225-1232). Here we show that temporal integration is critical for self recognition of face. Eight subjects were videotaped their faces by a handy video cam, which was shown at a video monitor (size: 20.7×22.3 deg, front-parallel). It was reversed to obtain mirror image. Subjects were asked to change facial expression (laugh etc) while temporal delay was introduced between camera and video by 1 to 6 seconds. They judged the magnitude of present feeling as well as feeling of self recognition respectively, both in five steps. Brain activities were measured simultaneously using Near Infrared Spectroscopy (NIRS). The rate of presence was found to decrease significantly, reaching asymptote to 10% in 3 seconds for all subjects. The rate of self recognition was similarly decreased in 4 subjects, while other 4 subjects kept high rating during whole periods. Hemodynamic brain activity revealed a significant decrease in 3 seconds at the parietal lobe. These results suggest that brain activity is correlated to the sense of presence, which is associated with self

recognition of face. This is consistent with the notion that temporal visual-proprioceptive integration is essential to the sense of presence related to recognition of self body (Blake et al, 2002).

m The speed limits of face perception

D H Arnold, O V Lipp (School of Psychology, University of Queensland, Australia;
e-mail: d.arnold@psy.uq.edu.au)

Despite extensive research, it is unclear how facial information is encoded. One debate concerns whether inverted and upright faces are encoded by distinct processes, or by a common mechanism attuned to upright faces. Another concerns whether analyses of emotional expression and structural characteristics, such as gender, are independent or interrelated. We addressed both issues by examining integration times—the durations for which information is accrued toward a perceptual decision. We found that gender judgments involve a protracted integration relative to expression judgments. This, however, was eliminated by inversion—with both judgments associated with a common, relatively rapid, integration. Our data show that upright facial gender and emotional expressions are processed independently, presumably via protracted holistic and more rapid featural analyses respectively. Moreover, our data suggest that all inverted face judgments rely on relatively rapid featural analyses.

m How di_erent is di_erent? Investigating criteria for di_erent identity judgments

H Hill[1], M Corcoran[1], P D Claes[2], J G Clement[2] ([1]School of Psychology, University of Wollongong, Australia; [2]Dental School, Melbourne, Australia; e-mail: harry@uow.edu.au)

Any face seen for the first time will have a closet neighbour in memory. In order to avoid false alarms, we must be able to distinguish similar from identical faces. Work is reported investigating same/di_erent judgments as a function di_erence in three dimensional shape defined in terms of standard deviation in a principal component based face space. The aim is to determine the criterion di_erence below which

observers respond ‘same’. A threshold corresponding to a d. of 1 was also calculated. Both were first measured under three conditions—same view images, di_erent view images and animated images of the faces rotating. Criterion did not di_er significantly between presentation conditions and the mean criterion corresponded to 0.45 SD when the average face was used as the reference. Threshold did di_er significantly between conditions, and was significantly higher for di_erent view faces (0.65 SD) than for same view (0.39 SD) or animated faces (0.44 SD). The results are interpreted as indicating that the criterion for same/di_erent judgments is relatively stable across presentation conditions, but that sensitivity is lower when making the judgment across a change in view. Further work will investigate whether criterion varies as a function of distinctiveness.

[Supported by ARC DP0986898]

m Cognitive categories of emotional and conversational facial expressions are influenced by dynamic information

K Kaulard[1], C Wallraven[1,2], S de la Rosa[1], H H Bülthoff[1,2] ([1]Dept of Human Perception, Cognition and Action, Max Planck Institute for Biological Cybernetics, Tübingen, Germany; [2]Dept of Brain and Cognitive Engineering, Korea University, Seoul, South Korea; e-mail: kathrin.kaulard@tuebingen.mpg.de)

Most research on facial expressions focuses on static, ‘emotional’ expressions. Facial expressions, however, are also important in interpersonal communication (‘conversational’ expressions). In addition, communication is a highly dynamic phenomenon and previous evidence suggests that dynamic presentation of stimuli facilitates recognition. Hence, we examined the categorization of emotional and conversational expressions using both static and dynamic stimuli. In a between-subject design, 40 participants were asked to group 55 di_erent facial expressions (either static or dynamic) of ten actors in a free categorization task. Expressions were to be grouped according to their overall similarity. The resulting confusion matrix was used to determine the consistency with which facial expressions were categorized. In the static condition, emotional expressions were grouped as separate categories while participants confused conversational expressions. In the dynamic condition, participants uniquely categorized basic and sub-ordinate emotional, as well as several conversational facial expressions. Furthermore, a multidimensional scaling analysis suggests that the same potency and valence dimensions underlie the categorization of both static and dynamic expressions. Basic emotional expressions represent the most e_ective categories when only static information is available. Importantly, however, our results show that dynamic information allows for a much more fine-grained categorization and is essential in disentangling conversational expressions.

TALK SESSION: COLOUR

m The representation of diagnostic chromatic texture in object-selective areas of human visual cortex

A C Hurlbert[1], Y Ling[1], I Pietta[2], Q C Vuong[1] ([1]Institute of Neuroscience, Newcastle University, UK; [2]Bioengineering Dept, Politecnico di Milano, Italy; e-mail: anya.hurlbert@ncl.ac.uk)

While behavioural experiments show that diagnostic surface colour and texture (eg a strawberry’s speckled red) drive object recognition as e_ectively as shape [Ling et al, 2009 Journal of Vision 9(8): 788], it is unknown how these cues influence object shape representations in the brain. Here we analyzed

fMRI measurements of human cortical activity in response to calibrated colour images of fruits and vegetables. Images were of 3 surface types: T (textured, 3D-shaded), F flat (textured, no shading), and U uniform (no texture-no shading), each with 3 colour types—D diagnostic, A atypical, G grey. Control objects (C) were generic 3D objects colour-matched to each condition. Subjects performed a one-back same-di_erent object classification task, regardless of condition. GLM parameter estimates representing activation strength were extracted from functionally localized object-selective and colour-selective visual areas and averaged across voxels and subjects. Together with frontal regions, the localised visual regions were found to respond best to fully textured, shaded objects in diagnostic colour (TD), worst for atypical colour (TA), and intermediately for 'grey' objects (TG). We conclude that object-selective areas encode not only shape but also other diagnostic properties of natural objects, in particular, chromatic texture.
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m Colour based target selection for ultrarapid saccades: The fastest controllable selection mechanism?

S J Thorpe, A Brilhault, M Mathey, S M Crouzet (CerCo, CNRS - Université Toulouse 3, France; e-mail: simon.thorpe@cerco.ups-tlse.fr)

Recent work with the saccadic choice task reveals that subjects can make very fast selective saccades towards certain key stimuli such as animals and human faces, with reliable saccades to faces appearing at 100–110 ms (Crouzet et al, 2010 J Vis). Interestingly, these ultra-fast saccades are di_cult to control, suggesting that they may reflect built-in biases in the visual system. For other relatively low-level visual features (eg orientation, direction of movement and shape) selective saccades need at least 150–170 ms, perhaps reflecting the time required for top-down selection. Colour appears to be an exception to this general rule. When a pair of coloured patches are flashed in the left and right visual fields (eg red and green), subjects can make fast and accurate saccades to a target colour from as early as 110 ms. Critically, they are able to switch the target category with ease. We propose that top-down selection mechanisms may influence the initial wave of processing in colour pathways, potentially as early as the LGN, thus increasing the e_ective salience of stimuli with particular colours. This ability to bias the very fastest saccades could play a vital function in visual search and may be unique to colour vision.

m Saliency and grouping interactions between colour–luminance and between colour–colour mixtures

F A A Kingdom[1], J Bell[1], E Gheorghiu[2], L Curran[1] ([1]McGill Vision Research, McGill University, Canada; [2]Laboratory of Experimental Psychology, University of Leuven (KU Leuven), Belgium; e-mail: fred.kingdom@mcgill.ca)

Aim. To determine the relative perceptual saliencies and relative grouping strengths of the components of suprathreshold mixtures of color-and-luminance and of colour-and-colour modulations. Method. The stimulus consisted of left- and/or right-oblique modulations of colour and/or luminance defined within a lattice of circles. In the 'separated' conditions the modulations were presented in separate lattices and subjects judged which lattice contained the more salient modulation. In the combined conditions both modulations were present within a single lattice and the subject indicated whether the dominant perceptual organization was left or right oblique. The relative modulation contrast at the PSE was calculated for both conditions. Results. For colour–luminance combinations in which the modulations were superimposed within the lattice, the PSE shifted between the 'separated' and 'combined' conditions, indicating that luminance was masked by colour. However, when the modulations were segregated within the lattice, the PSE shifted in the opposite direction, indicating stronger grouping for luminance compared to colour. For the colour–colour combinations, there was no consistent evidence that di_erent colour directions di_ered in terms of masking or grouping strength. Conclusion. Suprathreshold colour variations mask suprathreshold luminance variations but suprathreshold luminance variations group better than suprathreshold colour variations.
[Supported by Canadian Institute of Health Research grant #11554 to F.K]

m Evidence for isotropic detectors at low spatial frequencies in red-green colour vision from subthreshold summation experiments

K T Mullen[1], M Gheiratmand[1], T S Meese[2] ([1]McGill Vision Research, McGill University, Canada; [2]Neurosciences Research Institute, Aston University, UK; e-mail: kathy.mullen@mcgill.ca)

We have investigated the orientation tuning of chromatic mechanisms using a method of subthreshold summation. Stimuli were static sinewave gratings presented in sine phase in a 2D raised cosine envelope with a flat top (whole stimulus diameter=10 degrees) and in a temporal Gaussian envelope (_=125 ms). We ensured that no dc component was present in the stimuli. Stimuli isolated either the achromatic or chromatic L/M cone opponent mechanisms. A 2AFC method of constant stimuli was used to measure the amount of summation at detection threshold for combinations of 2 gratings of di_erent orientations (45 and 135 degrees) under monocular and dichoptic conditions. Chromatic orientation summation was measured at di_erent spatial frequencies (0.25–1.5 cpd). Greatest summation was found between the two orientations for the chromatic stimuli at low spatial frequencies under monocular but not dichoptic conditions. This e_ect was not found for the achromatic controls for which the two orientations were detected independently. Our results imply the presence of isotropic chromatic detectors in color vision

at low spatial frequencies (0.375 cpd and below) and indicate that these are monocular. Under other

chromatic conditions (higher spatial frequencies, dichoptic viewing) and for all achromatic stimuli we find evidence for orientation-tuned detectors.
[Grant support from CIHR Canada (MOP-10819) to KTM]

m Colours in the brain and synesthesia

J M Hupé[1,2], C Bordier[3,4], M Dojat[3,4] ([1]Laboratoire Cerveau et Cognition (CerCo), Toulouse University, France; [2]CerCo, CNRS, France; [3]Grenoble Institut des Neurosciences (GIN), U836, INSERM, France; [4]GIN, Université Joseph Fourier, France;
e-mail: jean-michel.hupe@cerco.ups-tlse.fr)

Functional MRI applied to human brain mapping has contributed to reenact the XIXth century localisationist idea that there is a specific area devoted to colour perception. What we know is in fact that the majority of visual areas give stronger BOLD responses to coloured Mondrians compared to isoluminant grey ones, with the stronger di_erential activation consistently appearing ventrally, along the fusiform and collateral sulci—each individual subject having a few hot spots in and anterior to retinotopically defined V4 [Brewer et al, 2005 Nature Neuroscience 8(8) 1102-1109]. The textbook story wants it that synesthetes activate V4 when viewing achromatic graphemes (but experiencing colour), suggesting that a bigger BOLD response corresponds indeed to functional localisation and that V4 activity is linked to colour experience. The published evidence is in fact scarce and ambiguous. We recorded the BOLD signal of 10 grapheme-colour synesthetes in a 3T scanner. We performed precise retinotopic mapping and identified for each individual its Mondrian colour centres (in and/or anterior to V4). Using both standard ROI and group analyses, we found no evidence of any activation in those colour centres by synesthetic colours. Our result favours a distributed coding of colour experience.
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m Positive color is perceived with dichoptic presentation in van Lier's afterimage phenomenon

T Sato[1], Y Nakajima[2] ([1]Dept of Psychology, University of Tokyo, Japan; [2]Intelligent Modeling Laboratory, University of Tokyo, Japan; e-mail: Lsato@mail.ecc.u-tokyo.ac.jp)

van Lier et al [2009 Current Biology 19(8) 323-324] reported a selection of negative color afterimages by subsequently presented contour stimulus. We report here the occurrence of positive, rather than negative, afterimage when the adaptor and test were presented dichoptically. The stimulus and procedure were almost the same as those used by van Lier et al The relative orientation between the red and green stars was varied between 0 to 45 degrees in 5 steps. The adaptor was presented monocularly for 1000 ms, and then the test contour was presented for 750 ms to either to the same or di_erent eye. It was found that the perceived color of afterimage changed gradually from one to the other complementary color (negative afterimages) according to the orientation di_erence (orientation tuning) when the adaptor and test were presented to the same eye. However, when they were presented dichoptically, afterimages in the same color were perceived (positive afterimages). It changes from the one to the other positive afterimage as the relative orientation varied. These results indicate that the color afterimage of this type was mediated both retinal and cortical processes, and it involves inhibitory as well as excitatory e_ects of the test contour.
[Supported by Ministry of Education, Science, Sports and Culture, Grant-in-Aid 21330167]

m Interpretation of the scene influences judgments of surface reflectance

E Brenner, J J M Granzier, J B J Smeets (Human Movement Sciences, Vrije Universiteit Amsterdam, The Netherlands; e-mail: e.brenner@fbw.vu.nl)

An object's colour is determined by how well it reflects light of various wavelengths. The visual system only has access to the reflected light. Nevertheless, people can judge surface reflectance quite reliably under natural conditions by also considering the light reflected by neighbouring surfaces. The present study examines whether only statistical image properties are considered when doing so, or whether an interpretation of the content of the scene is considered too. People indicated the judged reflectance of a small patch that was shown briefly on a simulation of a colourful ball by naming its colour. The ball was rotating slowly under a lamp. Patches were shown at two positions on the ball. People's judgments were less sensitive to di_erences in the colour of the surrounding when the di_erences were simulations of di_erent surface colours than when they were simulations of di_erences in illumination. The simulated origin of the colour change made no di_erence when only the directly adjacent parts of the ball were shown, or when asked to match the colour rather than to name it. We conclude that the interpretation of

the scene helps people judge surface reflectance. However, when matching surfaces' colours only the statistical properties are considered.

POSTER SESSION: 3D VISION, DEPTH II

m1

Perceived depth change by decreasing visual acuity in a dominant eye on binocular stereoscopic imaging

H Yamamoto, T Inoue, K Sadakuni, S Suyama (Dept of Optical Science and Technology, University of Tokushima, Japan; e-mail: suyama.shiro@opt.tokushima-u.ac.jp)

It is well known that stereoscopic image depth is di_cult to perceive when the eyes have di_erent visual acuity (Kobayashi et al, 2009 Perception 38 ECVP Supplement, 29-30). However, change of perceived depth by increasing the visual acuity di_erence has not been estimated quantitatively. In this study, we evaluated the perceived depth change by blurring the image of the dominant eye with binocular stereoscopic imaging. The perceived depth was measured by a method of adjustment. Subjects were asked to adjust the depths of clear upper- and under-rings to the perceived depth of a blurred middle stimulus ring. Results showed that perceived depth decreases continuously towards single-eye level on increasing image blurring of the dominant eye. When the amount of blurring compared to the stereoscopic image disparity is increased from 1/6 to 2/6, the perceived depth gradually decreases. When the amount of blurring is increased from 3/6 to 6/6, the perceived depth decreases rapidly. At more than 6/6, the perceived depth is equal to the single-eye level, meaning that the perceived depth of the stereoscopic image disappears altogether.

m2

Age dynamics of stereoacuity in school children

A E Belozerov[1], N N Vasiljeva[2], G I Rozhkova[1] ([1]Institute for Information Transmission Problems, Russian Academy of Sciences, Moscow, Russia; [2]Age and Special Psychology Dept, Chuvash State Pedagogical University, Cheboksary, Russia; e-mail: bell@iitp.ru)

At present, there is no consensus regarding age dynamics of stereoacuity in school children, mainly because the accuracy of measurements is usually limited by 20.. (arcsec). Some researchers believe that children reach the normal adult level at the age of 7 years, others have noted an improvement of stereoacuity up to 11–12 years. The purpose of our investigation was to assess the development of stereovision during the school period. In 178 children aged 7–17 years, stereoacuity was measured by means of the computer program 'Stereopsis' (Astroinform Ltd, Moscow). Test stimuli were anaglyph stereo pairs viewed through red-green glasses. They represented two high contrast vertical sinusoidal gratings, one above another, located at di_erent depths. The stereoacuity thresholds were measured in the range of spatial frequencies 0.4–8.0 cpd in half-octave steps. In all the age groups, similar U-shaped curves were obtained for dependence of threshold disparity on spatial frequency. The smallest thresholds were registered at 1.0–2.0 cpd. In the whole range of frequencies, the thresholds decreased 3–4-fold with age reaching their minimum at 14–15 years. At this age, the median values were 8.3..; at 1.4–2.0 cpd, with the range from minimum to maximum being 4.1–23.0... In elder children the thresholds increased at 1.4–8.0 cpd.

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m3

Distribution of visual acuity around fixation: Measures in real 3D space

A Köpsel[1], G Rinkenauer[2], M Grosjean[2], A Huckauf[1] ([1]Institut für Psychologie und Pädagogik, Universität Ulm, Germany; [2]Leibniz-Institut für Arbeitsforschung, TU Dortmund, Germany; e-mail: anne.koepsel@uni-ulm.de)

Knowledge about depth acuity is necessary, among other things, for evaluating 3D display technologies. Although the distribution of visual acuity along the horizontal and vertical dimensions has been well studied, acuity in real depth has received little attention. We developed a method to investigate and compare visual acuity in the peripheral visual field and in depth. Optotypes were presented tachistoscopically at various positions to the left and right of fixation (horizontal dimension), below and above fixation (vertical dimension), and in front of and behind fixation (depth dimension). The latter manipulation was achieved with the help of a semipermeable mirror. Stimuli were observed monocularly. As expected, recognition performance declined with increasing eccentricity at the three depths that were used (front, fixation, back). There was, however, an asymmetry in depth: Mean performance was best at the front depth, intermediate at fixation and worst at the back depth. This pattern is consistent with the notion that human depth acuity is observer- rather than object-centered.

m4

No room to swing a cat: How perceived narrowness influences depth perception

M Indino (Cognitive and Developmental Psychology, University of Zurich, Switzerland; e-mail: m.indino@psychologie.unizh.ch)

Perceptual space construction is based on invariant visual information inherent in the structure of the visual scene (Gibson, 1971 Leonardo 4 27-35). According to his direct perception view this is true both for three-dimensional natural environments and two-dimensional pictures. In turn, the horizon-ratio relationship (Sedgwick, 1973 DAI 34 1301-1302) refers to the ratio between the visual angles subtended between the bottom and the top of an object and between the bottom of the same object and the eye level, thus the horizon (cf. Rogers, 1996 Perception & Psychophysics 58 142-152). The present study analyzed these relationships from a developmental perspective employing functional measurement

(Anderson, 1996 A Functional Theory of Cognition Academic Press, NY). We investigated whether irrelevant—though very salient—visual information, such as the narrowness of a room, influences depth perception in children and adults. Participants had to mentally move objects in rooms of di_erent narrowness and in an outside environment. Afterwards they had to judge the perceived size of the object at the new position, taking into consideration the object's physical size and its distance to the horizon. The results reveal that the referential function of the horizon depends on the perceived extension of the environment in children as well as in adults.

m5

Stereoscopic memory beyond stimuli persistence: the multiplicative e_ect of binocular intervals

S I Rychkova[1], I E Rabitchev[1], J Ninio[2] ([1]Institute for Information Transmission Problems, Russian Academy of Science, Moscow, Russia; [2]Laboratoire de Physique Statistique, École Normale Supérieure Paris, France; e-mail: rych.sv@mail.ru)

Six subjects viewed twenty di_erent stereograms displayed one above the other on a monitor screen, using vertically deflecting prisms. The images were presented in alternation to the two eyes, the monocular presentation phases being separated by either binocular presentation intervals (BIs) or blank interocular delays (IODs). Both were varied by steps of 10 ms. For each value of the interval, we determined tmax, the largest duration of the monocular phases compatible with stable stereopsis. As expected, IOD increments needed to be compensated by comparable t_{max} decrements. Typical IOD limits were around 70 ms. They could be in the 25 ms range for RDS, or >100 ms for some subjects viewing simple stimuli. On the BI side, a 10 ms increase in BI produced a 20 to 100 ms increase in t_{max}, depending on the subject and on image complexity. Beyond 20 to 30 ms BIs, the multiplicative e_ect could still increase. At still larger BIs (eg 100 ms BI and 400 ms monocular phases) the subjects experienced a steroscopic percept which oscillated between a left and a right biased percept. Our results suggest the existence of a rather stable stereoscopic memory, sustained by brief occasional updates.

m6

The e_ect of blur gradients on the perception of distance and slant

D Vishwanath[1], E Blaser[2], P Donaldson[1] ([1]School of Psychology, University of St Andrews, UK; [2]Dept of Psychology, University of Massachusetts, USA; e-mail: dv10@st-andrews.ac.uk)

Viewing a slanted surface can produce a gradient of blur on the extra-foveal retina, the magnitude of which depends on the distance of fixation. We examined perceived distance and slant for images of natural surfaces while varying the magnitude and direction of slant (tilt 0 and 90), as well as the magnitude and direction of blur. Blur had large e_ects on perceived distance, for both horizontal and vertical slants, even when the direction of blur was orthogonal to the underlying slant, and therefore not optically consistent with it. The magnitude of the distance e_ect depended on the degree of blur. Consistent with prior reports [Watt et al, 2005 Journal of Vision 5(10):7, 834-862] we found that blur a_ected perceived slant. The e_ect of blur at tilt=90 was larger, and depended on the degree of blur. For tilt=0, The e_ect of blur was attenuated for higher levels of blur and large slants. We also found that the perceived magnitude of blur itself depended on blur direction, with horizontal blur gradients appearing blurrier than physically identical vertical ones.

m7

Investigating stereopsis with a binocular adaptive optics visual simulator

E J Fernandez, P M Prieto, P Artal (Laboratorio de Optica, University of Murcia, Spain; e-mail: enriquej@um.es)

The optical quality of retinal images set a first limit to vision. Adaptive Optics is a technology enabling the controlled manipulation of the eye's optical aberrations that has been successfully demonstrated for visual simulation. Subjects can experience vision through a variety of manipulated optical conditions. Visual simulation has emerged as a powerful tool for understanding the relationship between the eye's

optics and visual performance. So far, experiments have been carried out under monocular conditions. We will present here the first binocular adaptive optics visual simulator specifically devised for the investigation of stereopsis and in general, binocular vision. The apparatus is capable for manipulating the aberrations of each pupil, while subjects perform visual tests. Stereoacuity tests, three needle test and random-dot stereogram, have been programmed for demonstrating the performance of the method. Examples of the potential of the instrument will be shown, measuring stereoacuity in presence of defocus, and trefoil aberration. First results show a complex relationship between aberrations and stereopsis. With this instrument, novel studies could be devised for exploring the relationship among each eye's optics, spatial acuity, stereopsis and other binocular characteristics.

m8

View-based models as an explanation for human navigation errors

L C Pickup[1], S J Gilson[2], A Glennerster[1] ([1]School of Psychology and CLS, University of Reading, UK; [2]Dept of Physiology, Anatomy and Genetics, University of Oxford, UK; e-mail: lyndsey.pickup@gmail.com)

View-based and Cartesian representations provide rival accounts of visual navigation in humans. Here

we show that the distribution of errors in navigation on the scale of a room are strongly influenced by the scene geometry, in ways that can be modelled using only simple view-based features. Participants were asked to complete a homing task in an immersive virtual reality environment. In interval one they were shown three very long coloured vertical poles from one viewing location with some head movement. They were transported to another location, and in interval two, tried to navigate to the initial viewing point. The distributions of end-point errors on the ground plane di_ered significantly in shape and extent depending on pole configuration and goal location. A model based on simple features (eg angles between poles from the cyclopean point, or ratios of these angles) captures important characteristics of these distributions even without 3D elements such as stereo and motion parallax. Augmentations of the feature space that include this information (eg vergence angles or disparity gradients) result in a set of models which describe the data accurately, demonstrating the e_ectiveness of a view-based approach.
[Supported by the Wellcome Trust (086526/A/08/Z)]

m9

Attention modulates depth in nontransi**tive** stereo displays

B Farell, J M Fernandez (Institute for Sensory Research, Syracuse University, USA;
e-mail: bfarell@syr.edu)

Predicting the depth seen in stereoscopic displays usually requires a consideration of horizontal disparities, but not always. The perceived depth of a one-dimensional stimulus, like a grating, is more accurately predicted by considering the disparity vector of this stimulus relative to the disparity vector of the reference stimulus its depth is judged relative to, without bringing horizontal disparity into the calculation. In these cases perceived depth depends on disparity direction as well as magnitude, making it possible to create nontransitive depth relations: Stimulus B is seen as farther than Stimulus A when they are presented together; Stimulus C is seen as farther than Stimulus B when they are presented together; but Stimulus A is seen at the same depth as Stimulus C when they are presented together. What depths are seen when A, B, and C are all presented together? We show that selective attention can modulate these nontransitive depth-pairings. Observers judged the depths of subsets of the three stimuli. Attending to stimuli pairs attenuated but did not eliminate the e_ect of the disparity of the unattended stimulus. Attending to all three stimuli yielded depths that are not predicted by the individual disparities themselves.
[Supported by NIH grant EY-012286]

m

10

Exploring the link between depth perception, hand–eye coordination and parietal lobe activation during robotic-assisted interventions

G Paggetti[1], G Menegaz[1], D R Le_[2], F Orihuela-Espina[2], A Darzi[2], G-Z Yang[2] ([1]Dept of Computer Science, University of Verona, Italy; [2]Biosurgery and Surgical Technology, Imperial College London, UK; e-mail: giulia.paggetti@univr.it)

The posterior parietal cortex (PPC) is known to be involved in stereoscopic vision [Shikata et al, 1996 Neuroreport 7(14) 2389], visual control of eye movements and hand–eye coordination [Ferraina et al, 2009 Neuropsychologia 47(6) 1409-1420]. This brain region may play an important role in robotic assisted intervention which provides the surgeon with a stereoscopic view of the operative field combined with aligned motor-visual axes and mechatronically controlled instruments. Theoretically, performers with superior technical ability may demonstrate enhanced neuronal e_ciency compared to those who struggle in robotic environments. Our study explores the link between technical ability

and PPC activation during depth perception and a hand–eye coordination task in a robotic surgical environment. The results suggest that a link may exist between technical performance, depth perception capability and PPC activation. Subjects with poorer technical and depth perception capability seem to activate the bilateral PPC more broadly than subjects with superior visuospatial ability and technical skill. Moreover, subjects reaching an ‘intermediate’ level of performance in both tasks demonstrate ‘intermediate’ levels of bi-parietal activation.

m

11

Joint e_ects of surface texture and relative height in infant pictorial depth perception

M Kavšek, L Hemker (Institute for Psychology, University of Bonn, Germany;
e-mail: kavsek@uni-bonn.de)

In a series of preferential-reaching experiments, we tested 7-month-old infants for their ability to respond to the combination of relative height and a highly regular background texture, to the combination of relative height and an irregular background texture, and to relative height in isolation. The regularity of the background texture was manipulated by adding (regular background texture) and deleting (irregular background texture) the depth cue of linear perspective within the surface texture. Experiments 1 and 2 tested infants’ responses to relative height in isolation and to relative height combined with regular texture. The participants responded to both kinds of cues. Experiment 3 demonstrated that infants perceive depth specified by relative height in combination with irregular background texture. In

Experiment 4, relative height and irregular texture provided the infants with conflicting depth information. The infants responded to relative height and not to irregular texture. Statistical comparisons revealed that the irregular texture neither enhanced nor weakened the e_ect exerted by relative height. In contrast, a highly regular texture resulted in an increase of 7-month-olds' reaching responses that went significantly beyond the impact of relative height in isolation. The study therefore suggests that 7-month-old infants are sensitive to relative height and to regular, but not to irregular background texture.

m

12

The role of monocular and binocular cues and egocentric distance in depth perception between two objects in immersive virtual environment

M Valente, V Zappi, A Brogni, D Caldwell (Istituto Italiano di Tecnologia, Italy; e-mail: massimiliano.valente@iit.it)

Many researchers suggested that distances from the observer are more likely to be underestimated in virtual environments than in real-world conditions. Our aim was to estimate whether or not depth distance underestimation is present in distance judgment between two objects. Moreover, we have analyzed the weight of monocular and stereoscopic cues in inter-objects distance perception in immersive 3D environment. Each session was characterized by presence of one or more monocular cues (occlusion, relative size and linear perspective). In experimental setup two virtual objects appeared for 600 ms in front of the subject at the same time. The subjects were asked to specify which object was closer to them. Three di_erent backgrounds have been used, with a grid, a texturized plane, or an empty space. We presented three sessions, in random order, and related to the di_erent clues: preservation of object's perspective size, occlusion, and same retinic dimension of objects. The data analysis of normal perspective and same retinic size sessions showed a significant e_ect of egocentric distance, but there was no di_erence between the sessions. The analysis of monocular cues data showed the influence of perspective size and information background but these e_ects are not significant.

m

13

Read-out rules for short-latency disparity-vergence responses from populations of binocular energy units: the e_ect of vertical disparities

A Gibaldi, A Canessa, M Chessa, S P Sabatini, F Solari (Dept of Biophysical and Electronic Engineering, University of Genoa, Italy; e-mail: agostino.gibaldi@unige.it)

The involuntary control of vergence eye movements has been related to inputs directly derived from an early stage of cortical processing (Masson et al, 1997 Nature 389 283-286). Considering a population of V1-like disparity detectors, jointly tuned to both horizontal (HD) and vertical (VD) disparity, we sought to properly combine their responses to achieve vergence control for large HD, that well tolerates VD (Gibaldi et al, 2010 Neurocomputing 73 1065-1073). Here, we analyze how VD tuning does e_ects the short-latency disparity-evoked vergence. With the straight-ahead gaze, the average VD around the fovea is close to zero, but at di_erent directions, it arises to sensitive values. Although the control yields stable fixations at any binocular azimuth and elevation, it still exhibits a bias on VD. The major contribution for horizontal vergence derives from cells mostly tuned to VD, while their responses are weighted to strongly reduce the dependence on VD within its variability across the tested gaze directions. As reported in humans (Yang et al, 2003 Vision Research 43 431-443), the model yields the strongest

responses when the VD is close to zero, whereas the responses decline as the VD increases. The role of isotropic representations of stereo correspondences through oriented disparity channels across the visual field is investigated.

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m

14

When does non-visual information a_ect vision—perceived distance anisotropy in full-cue and reduced-cue conditions

O Toskovic[1,2] ([1]Dept of Psychology, Faculty of Philosophy, Kosovska Mitrovica, Serbia; [2]Laboratory for Experimental Psychology, Faculty of Philosophy, Belgrade, Serbia; e-mail: otoskovi@f.bg.ac.rs)

In previous research we showed that in reduced-cue condition, physically shorter vertical distances are seen as equal to physically longer horizontal distances. The aim of the present research was to investigate whether the same regularity can be found in full-cue condition. The first experiment was done in a dark room (reduced-cue), with 13 participants, and the second on an open field during the day (full-cue), with 24 participants. In both experiments participants had the task to equalize the perceived distances of three stimuli in three directions (0, 45, and 90 degrees regarding body orientation). One of the stimuli was the standard, and participants matched distances of other two with the standard. Participants performed distance matches while lying on the floor, on their left side, wearing special glasses to prevent the subjects eye movements. For distance matches in reduced-cue condition we found such di_erences between three directions, that as the head tilts upwards, the perceived space is being elongated, which

coincides with earlier results. On the other hand, for distance matches in full-cue condition, we found no di_erences between three directions, which might mean that visual system relies less on proprioceptive information when visual information is su_cient.
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m
15
A far object helps judge a nearer one's distance without being localized itself
R Sousa, E Brenner, J B J Smeets (Human Movement Sciences, Vrije Universiteit Amsterdam, The Netherlands; e-mail: ritass@gmail.com)
The presence of a more distant object helps judge an object's distance: the relative disparity between the two objects is considered. Does this mean that the di_erence between the perceived locations of the two objects is consistent with the relative disparity between them? To find out we examined whether misjudging a cube's location induces a corresponding misjudgment of a nearer sphere's location. A virtual sphere and cube were presented at various positions in total darkness. Subjects had to indicate where they saw each object (on separate trials) with their unseen index finger. Three cube sizes were used. Most subjects judged a larger cube to be nearer than a smaller one that was at the same position. Cube size did not influence judgments of the sphere's position. Thus the distance judgments were not consistent with the relative disparity between the objects. This contradicts claims that the furthest object is used as an anchor point for distance judgments. It supports our proposal that the relative disparity between two objects limits the range of possible positions of the nearer object. This e_ect is a direct consequence of the relative disparity, so the perceived object locations do not need to be consistent with the relative disparity.

m
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Individual di_erences in stereo acuity
J M Bosten[1], R E Hogg[1,2], G Bargary[1], P T Goodbourn[1], A J Lawrance-Owen[1], J D Mollon[1] ([1]Dept of Experimental Psychology, University of Cambridge, UK; [2]Centre for Vision and Vascular Science, Queen's University, UK; e-mail: jmb97@cam.ac.uk)
Here we report the range and reliability of individual di_erences in stereo acuity in a large, wellcharacterised population. We tested 1000 participants aged 16-40 on a novel test of stereo acuity and on the TNO test. Participants had their monocular and binocular visual acuity measured and corrected. They were assessed for strabismus by means of a cover test, and by cards for detecting lateral and vertical phorias presented using a telebinocular. Contrast sensitivity was assessed separately for each eye, as was the magnitude of binocular masking. We report the range and distribution of individual variability for each of our measures, and the correlations between them. We also report test–retest reliabilities measured using a random 10% of our sample.
[Supported by the Gatsby Foundation]
Poster session: Brightness, lightness
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Estimation of perceived depth with di_erent visual acuities for 3-D display using two fingers
K Sadakuni, T Inoue, Y Kobayashi, H Yamamoto, S Suyama (Dept of Optical Science and Technology, University of Tokushima, Japan; e-mail: sadakuni_k@opt.tokushima-u.ac.jp)
Perceived depths measurement method by distance between two fingers using a caliper is widely applicable for estimation of depth perception (Kuribayashi et al, 2007 Perception 36 ECVP Supplement, 183). By using this method, we can successfully obtain the perceived depth of real objects when both eyes have di_erent visual acuities. When the eyes have same visual acuity, the perceived depth change is almost the same as the depth change of real object. However, when the eyes have di_erent visual acuities, the amount of perceived depth change is decreased. As the visual acuity di_erence is increased, the perceived depth changes are gradually decreased. When visual acuity of dominant eye is 0.1, the perceived depth change is decreased to 80%. When visual acuity of dominant eye is 0.07, the perceived depth change is decreased by half. When visual acuity of dominant eye is decreased to 0.01, the depth of real object is di_cult to perceive. Even if visual acuity di_erence is changed, linearity between perceived depth and real object distance is maintained.

POSTER SESSION: BRIGHTNESS, LIGHTNESS

m
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Lack of reflectance constancy even with the surrounding context
I Motoyoshi[1,2], H Matoba[2,1] ([1]Human and Information Science Laboratory, NTT Communication Science Laboratories, Japan; [2]Dept of Information Processing, Tokyo Institute of Technology, Japan; e-mail: motoyosi@apollo3.brl.ntt.co.jp)
Recent psychophysical findings suggest that the perceived reflectance of an object depends on the histogram statistics of the illumination such as contrast and skewness. In natural environments, these

statistics can vary with the weather and so on, but we rarely see changes in the perceived glossiness and color of objects. This might be because the visual system can utilize rich contextual information in natural scenes. To test this possibility, we created a computer-generated scene consisting of many 3D objects, and asked subjects to match the specular and di_use reflectance of the target object in the scene under a fixed illumination field to that in the scene under di_erent illumination fields with variable mean, contrast, and skewness. We found that the matched reflectance was relatively constant against changes in the mean illuminance, but substantially varied with changes in the contrast and skewness of the illumination field. These results are consistent with the notion that even with rich surrounding information, the perceived reflectance depends on the structure of illumination, except for the mean illuminance. The matching data were well predicted by the image subband histogram, suggesting a strong impact of simple image statistics on the estimation of surface reflectance.

m

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Two di_erent illusory e_ects in the Spillmann–Levine grid

J Geier[1], M Hudák[2], B Lingelbach[3] ([1]Laboratory of Visual Science, Stereo Vision Ltd, Hungary; [2]Dept of Cognitive Science, Budapest University of Technology and Economics, Hungary; [3]Lingelbachs Scheune, Institut für Augenoptik Aalen, Germany; e-mail: janos@geier.hu)

We compared the distortion tolerance of the Hermann grid with that of the Spillmann–Levine grid (Spillmann and Levine, 1971 Exerimental Brain Research 13 547-559). We define distortion tolerance as the amplitude of the curvature of the grid at which the illusory spots disappear. In the experiment we used 4 di_erent distortion types (described in Geier et al, 2008 Perception 37 651-665) with 22 naive subjects. Starting from straight-lined grids, the subjects increased the amplitude of the curvature until the illusion disappeared. At the classical Hermann grid, the spots disappeared for every subject. At the Spillmann– Levine grid, in 20% of the cases the spots did not disappear, however all subjects reported significant weakening of the illusion. For the other 80% of the subjects the distortion tolerance of the Spillmann–Levine grid was two times higher than that of Hermann grid. These results refute Hamburger and Shapiro's statement that curvature does not eliminate the illusion (Hamburger and Shapiro, 2009 Vision Research 49 2121-2130). As opposed to Hermann grid, all subject see the spots even foveally in the Spillmann–Levine grid. We conclude that two di_erent illusory e_ects are summed in the Spillmann–Levine grid: the Hermann grid illusion and grating-induction.

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Thursday

Poster session: Brightness, lightness

m

20

Intertrial e_ect in luminance processing revealed by MEG

A Kondo[1], H Tsubomi[1], K Watanabe[1,2] ([1]Research Center for Advanced Science and Technology, University of Tokyo, Japan; [2]HSBE, National Institute of Advanced Industrial Science and Technology, Japan; e-mail: kondo@fennel.rcast.u-tokyo.ac.jp)

In this study, we examined whether luminance processing in the human visual system would exhibit any history e_ect (ie, intertrial modulation) in psychophysical and magneto-encephalographic experiments. A disk was presented against a black background at various luminance levels in a randomized order. In the psychophysical experiment, participants rated the perceived brightness of the disk (magnitude estimation). In the MEG experiment, participants were instructed to passively observe the disk and were not required to rate the brightness. The MEG results showed that the stimulus presentation evoked neuromagnetic responses around 150 ms after the stimulus onset in the occipito-temporal regions. As expected, the activation was generally stronger for the stimuli higher luminance. However, we also found an intertrial assimilation e_ect; that is, the neuromagnetic activation at a given trial was stronger when the disk luminance was higher in the immediately prior trial. A similar intertrial e_ect was also observed in the psychophysical experiment. These findings suggest that the neuromagnetic activity reflects the intertrial modulation of luminance processing that correlates with the subjective perception of brightness.

[Supported by MEXT, JSPS, and JST]

m

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The snake illusion and cues for edge classification

S Zdravkovic[1], D Todorovic[2] ([1]Dept of Psychology, University of Novi Sad, Serbia; [2]Dept of Psychology, University of Belgrade, Serbia; e-mail: szdravko@f.bg.ac.rs)

The lightness of a target is a_ected not only by its immediate background but also by nonadjacent portions of the display. It has been suggested that the shape of nonadjacent background elements plays an important role in the determination of lightness, because the visual system tends to interpret curved edges as reflectance edges and straight edges as illumination edges. To test the lightness e_ect of the shapes imbedded in the nonadjacent background we used the snake illusion, presented on a calibrated monitor placed in a dark void. Observers performed the lightness matches by adjusting the luminance of comparison patches. We replicated the e_ect in its standard form, but found that it persists undiminished in variants of the display with straight edges that violated the transparency conditions.We also replicated

the decline of the e_ect in a display involving curved edges, but found that it did not diminish in strength in a di_erent display with curved edges. Thus our data suggest that the snake illusion may not be explained solely on the basis of edge classification and transparency/shadow perception. Also, we found that the e_ect was limited to the middle and light gray targets.
[Supported by a Ministry of Science and Environmental Protection of Serbia grant]

m
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Scintillation in the Spillmann–Levine grid
M Hudák[1], J Geier[2], B Lingelbach[3] ([1]Dept of Cognitive Science, Budapest University of Technology and Economics, Hungary; [2]Laboratory of Visual Science, Stereo Vision Ltd., Hungary; [3]Lingelbachs Scheune, Institut für Augenoptik Aalen, Germany; e-mail: mhudak@cogsci.bme.hu)
We examined the scintillating e_ect (Schrauf et al, 1997 Vision Research 37 1033-1038) in the Spillmann–Levine grid (Spillmann and Levine, 1971 Experimental Brain Research 13 547-559). If we put light disks in the intersections, the disks scintillate, even when the horizontal and vertical streets are very di_erent in luminance (levels: horizontal=40, vertical=180, disk=255, in 0–255 range). If only horizontal or vertical streets are present, (levels: horizontal=50–150, vertical=0, or vice versa, disks=255) the disks also scintillate. The scintillation is present even in inverse grids (white background, black disks).We also low-pass Gauss filtered the Spillmann–Levine grid. The scintillation is visible in the filtered grids, when the intersecting streets are equal or lighter than the intersected streets. These results contradict Hamburger and Shapiro's (2009 Vision Research 49 2121-2130) statement that low-pass filtered luminance-mismatched weaves do not create scintillating patterns. Our conclusion is that the equal luminance of the horizontal and vertical streets is not a necessary condition for scintillation; it is su_cient to have only horizontal or vertical streets. Neither is lowpass filtering a necessary condition, though it is su_cient. The neccessary condition is that the intersections are lighter than the streets, even when the streets are not equal in luminance.

Poster session: Brightness, lightness
Thursday
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Modelling glare e_ects on brightness perception
P A Barrionuevo, E M Colombo, L A Issolio (ILAV, Universidad Nacional de Tucumán, Argentina; e-mail: pbarrionuevo@herrera.unt.edu.ar)
The brightness of a mesopic test is a_ected by peripheral glare in transient conditions, when the surround luminance is in the low mesopic or scotopic region. This loss of constancy seems to be caused by the change in excitation from rods to cones led by the increment of retinal illuminance due to glare. We present new complementary results and a model of these brightness variations. Three young subjects evaluated the brightness of a transient foveal test when a peripheral glare (60 lx, 10°) was simultaneously presented. The stimuli were increments with luminance of test (L_t) and surround (L_s) between 0.001 and 4 cd/m^2. The e_ect of the surround luminance on the test brightness prevailed over the e_ect of the test luminance while the highest e_ect of the test was obtained when the surround was the minimum. Results were fitted using an exponential function with only two parameters considering L_s as the independent variable. The exponential fit used can model, with enough goodness, in addition to the e_ects of surround, the e_ects of test and adaptation.
[Supported by CIUNT(26/E410) and ANPCyT(PICT06/1920)]

m
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Subjective modulation of brightness in the successive presentation of luminance stimuli
P M E Claessens[1], M V C Baldo[2] ([1]Centro de Matemática, Computação e Cognição, Universidade Federal do ABC, Brazil; [2]Instituto de Ciências Biomédicas, Universidade de São Paulo, Brazil; e-mail: peterpc5j@hotmail.com)
Behavioural data indicate that, when a pair of spatially separated luminance stimuli is presented sequentially, the second stimulus tends to appear brighter than the first. In a basic experimental paradigm, pairs of grey disks with a 15% luminance di_erence are presented in opposite sides of the screen with stimulus onset asynchronies (SOA) from 0 to 200 ms. On judging which of both stimuli has higher or darker luminance, observers respond more accurately when the first disk is the darker of both while performance dips significantly below chance level when the opposite is true ($p<0.0001$, likelihood ratio test). The fact that this occurs independently of whether the brighter or darker element is to be identified precludes temporal order bias as the cause of this e_ect. In a series of experiments, we explore factors modulating the magnitude of this e_ect, including SOA, global luminance level, element separation and eccentricity, and physical characteristics of the visual stimulation. Implications for hypotheses about the origin of this sequential brightness e_ect, which include explanations in terms of attention and low-level physiological processes, are discussed.
[Supported by FAPESP (2006/50189-9)]

m
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E_ects of belongingness and size on lightness in stereoscopic displays
O Daneyko[1], D Zavagno[2] ([1]Dept of Psychology 'Gaetano Kanizsa", University of Trieste, Italy;
[2]Dept of Psychology, University of Milano-Bicocca, Italy;
e-mail: OLGA.DANEYKO@phd.units.it)
Three experiments were conducted to study the e_ects of depth and size on lightness in stereoscopic displays. In Experiment 1 two targets physically equal in size were viewed simultaneously against homogeneous incremental or decremental backgrounds; one target appeared floating in space on a front plane, the other appeared in depth coplanar to the background. Experiment 2 employed a similar setup but with targets di_erent in size pairwise (0.36° and 0.65°). In Experiment 3, targets were di_erent in size but always coplanar (both floating in a front plain or both coplanar in depth to the background). Results: with isoluminant targets in Experiments 1 and 2, the target that was coplanar to the background (far) appeared lighter or darker depending on whether it was an increment or decrement to the background. Results support the hypothesis that target-background belongingness is an important factor in lightness perception, while target size di_erences in Experiment 2 did not determine significant e_ects. In Experiment 3, instead, the target that was bigger appeared also lighter or brighter depending on whether it was an increment or decrement to the background. Results are discussed in relation to literature on the e_ects of depth, belongingness, and size on lightness.
[We thank Tohoku Gakuin University in Sendai for its support]
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Thursday
Poster session: Contrast
m
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What picture perception can teach us about lightness and brightness
D Zavagno[1], O Daneyko[2], K Sakurai[3] ([1]Dept of Psychology, University of Milano-Bicocca, Italy;
[2]Dept of Psychology 'Gaetano Kanizsa", University of Trieste, Italy; [3]Dept of Psychology, Tohoku Gakuin University, Japan; e-mail: daniele.zavagno@unimib.it)
Theories on lightness (achromatic surface colour) can be divided into two groups: theories (LT) that account for lightness without need to refer to illumination, and theories (ST) that account for lightness in terms of a scission between surface colour and brightness components of a visual scene (typically illumination). We bring evidence from a collection of data and demos that lightness and brightness are interrelated phenomena. The demos relate to picture perception and they challenge both current LT models and ST models. In fact we do not claim that LT models are necessarily wrong, or that ST models are intrinsically correct.We claim that the picture is unclear because research has always focused primarily on possible bottom-up, midway, or top-down solutions to the problem represented by lightness constancy and its numerous failures, while very little has been done to understand and model brightness. We present some historical reasons behind this lack of interest, along with the sketch of a model that takes into account the interaction between lightness and brightness.
m
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Spatial attention, illumination frameworks, and grouping by surround similarity in lightness perception
M E Rudd (Howard Hughes Medical Institute, University of Washington, USA;
e-mail: mrudd@u.washington.edu)
Arend and Spehar (1993) showed that lightness matches made with simple displays such as disk-and-ring stimuli are influenced by instructions to imagine the target and matching configurations as belonging to either a single global illumination framework or separate local frameworks. Here I discuss a new lightness grouping e_ect that occurs only when the subject attends to the global illumination framework [Rudd, 2008 Journal of Vision 8(6):287, 287a]. The likelihood that a subject's lightness matches will be based on a luminance comparison between the target and its local surround depends on the luminance similarity between the target and match surrounds. This 'surround similarity e_ect' produces lightness assimilation and contrast over di_erent ranges of the target surround luminance. When the subject views the target and matching configurations as belonging to separate local frameworks, the surround similarity e_ect and assimilation disappear. Thus grouping by surround similarity explains assimilation. The global and local attention results each conform to a simple set of mathematical rules motivated by ecological considerations. Naïve (ie uninstructed) matches are modeled as a mixture of the matches predicted from models based on local edge analysis and global luminance cues. Errors in lightness constancy are explained in terms of a compromise between reliance on the local versus global cues.
POSTER SESSION: CONTRAST
m
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Perceptual quirk induces safe driving in fog
P Pretto, J-P Bresciani, H H Bültho_ (Dept of Human Perception, Cognition and Action, Max Planck Institute for Biological Cybernetics, Tübingen, Germany;
e-mail: paolo.pretto@tuebingen.mpg.de)
Perceived speed of moving patterns is lower when visual contrast is reduced. In recent driving simulation

experiments, this has been presented as an explanation why drivers might drive too fast in fog. In this simulation, contrast was equally reduced for all objects in the scene, independently of their distance from observer (distance-independent contrast reduction). In fog, however, contrast is reduced more for more distant objects (distance-dependent contrast reduction). We compared the e_ects of these two types of contrast reduction on both perceived and actual driving speed. In the first experiment twelve participants were presented with pairs of driving scenes—one with clear visibility, one with reduced contrast—and instructed to estimate which scene moved faster. Speed was underestimated with distance-independent contrast reduction but overestimated with distance-dependent contrast reduction. In the second experiment, ten drivers drove at target speeds under clear and reduced visibility conditions without tachometer. Participants increased speed with distance-independent contrast reduction but decreased speed with distance-dependent contrast reduction. These results show how visibility loss can lead to opposite perceptual and behavioural e_ects, depending on the nature of the underlying visual contrast reduction. In fog, indeed, the visual system fools drivers the safe way, advising them to decelerate.

Poster session: Contrast

Thursday

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m

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Lightness constancy and simultaneous lightness contrast in patients with brain damage

A Fumarola[1], T Agostini[1], K Priftis[2,3], A Lunardelli[4], C Umiltà[2] ([1]Dept of Psychology, University of Trieste, Italy; [2]Dept of Psychology, University of Padova, Italy; [3]IRCS San Camillo, Venezia, Italy; [4]Ospedale Maggiore, Ospedali Riuniti Trieste, Italy; e-mail: antonia.fumarola@gmail.com)

The neural mechanisms responsible for the presence of simultaneous contrast have not yet been identified. Agostini and Galmonte [2002 Psychonomic Bulletin & Review 9(2) 264-269] showed that the e_ect of luminance gradient on achromatic simultaneous contrast ('glow e_ect') is much stronger than the classic achromatic simultaneous contrast e_ect. In this respect, Leonards et al (2005 Cognitive Brain Research 24 173-176) suggested that there is a region of the extrastriate cortex (in the occipito-temporal and/or collateral sulcus at the border between Brodmann areas 19 and 37) which responds to the perceived 'glow 'or 'self-luminosity' component of visual stimuli. We examined whether the patients with brain damage perceived the simultaneous contrast and whether they showed a di_erence between the classical achromatic simultaneous contrast e_ect and the e_ect of luminance gradient on achromatic simultaneous contrast. The patients with the left damage do not show a di_erence between the classical simultaneous contrast e_ect and the e_ect of luminance gradient on simultaneous contrast, instead the patients with right damage perceive di_erently the contrasts presented in the study of Agostini and Galmonte.

m

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E_ect of yellow tinted spectacle lenses on intraocular straylight

G Ikaunieks, A Stepanovs, M Ozolinsh (Dept of Optometry and vision science, University of Latvia, Latvia; e-mail: gatisik@lu.lv)

There is lot of discussion about the e_ect of yellow spectacle lenses on vision. One of the main question is can we improve visual functions with yellow lenses? It has been suggested that removal of blue light with yellow lenses may reduce light scattering, thus could increasing visual performance. We wanted to test this suggestion. Intraocular straylight with and without yellow lenses in front of the eye was measured by direct compensation method [van den Berg, 1986 Doc. Ophthalmol 61(3/4) 327-333]. In addition the e_ect of yellow lenses on contrast sensitivity was assessed using the Pelli–Robson contrast sensitivity chart and a special computer program. Results showed that the straylight was stronger in measurements with yellow lenses than in normal conditions. Contrast sensitivity measurements did not show statistically significant improvement with yellow lenses, however most of the subjects feel more comfortably with yellow lenses, especially in mesopic light conditions. Our results agree with those of previous studies [Rabin and Wiley, 1996 Ophthalmic Physiol. Opt 16(1) 68-72)] which showed that improvement of vision looking though yellow lenses is related more with neural factors than optical ones.

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m

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Intrinsic contrast vs perceived contrast: a physiological approach to legibility

L Rossi[1,2], G Rossi[3], P Iacomussi[3] ([1]Dept of Production Systems, Politecnico di Torino, Italy; [2]Dept of Thermodynamics, INRIM, Italy; [3]Optics Dept, INRIM, Italy; e-mail: laura.rossi@polito.it)

The detection of a displayed message is the first step of the cognitive process to identify its meaning. It can be psychophysically evaluated through measurement of contrast. The intrinsic contrast (Ci) is a physical parameter depending on display characteristics and environmental light distribution. The perceived contrast (Cp) is our real parameter of interest and it is obtained from Ci considering the veiling luminance (LVeil), evaluated with a mathematical model of the eyes properties. Disability glare is due to the scatter of light within the eye, and it results in veiling light superimposed over the normal scene, e_ectively reducing contrast of objects observed. On equal conditions of vision, it reduces perceived

contrast and its value can descends under the threshold of perception making not legible the information displayed otherwise perfectly detectable. We calculate Cp adding LVeil both on target and background luminance, to Ci: As LVeil increase, Rc (Cp /Ci) goes from 1 to 0, Cp decreases and can reach a value under the contrast threshold rendering the character illegible. To evaluate the veiling luminance we used the CIE general disability glare equation, where glaring sources can be 'single points' or 'large surround sources'. Simulations of worst cases have been done with the method described.

m

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Can CSF high-frequency roll-o_ be derived from retinal line spread function?

V E Doubrovski, A V Garusev (Dept of Psychology, Lomonosov Moscow State University, Russia; e-mail: vicdubr@mail.ru)

It has long been known that contrast sensitivity function (CSF) is decreasing exponentially in highfrequency range, and is approximated well by exponential function S(f)=A exp(−kf). Assuming that an attenuation of CSF is determined mainly by the eye optics, the analytical expression (referred to as

Lorentzian) I(x)=I0/[x2+(□/2)2] for retinal line spread function (LSF) is derivable by Fourier transform. The scale parameter □ specifies the width of LSF, and k=_□. The relationship permits to compare quantitatively various experimental CSF and LSF shapes (provided that LSF is really fitted well with Lorentzian). We validated CSF exponential approximation in large set of psychophysical experiments (Doubrovski et al, 2006 Perception 35 ECVP Supplement, 49). The value for k was found to fall in the range 0.09 to 0.16 arc deg. To measure LSF the double-pass method is commonly used. However results tend to be somewhat contradictory. For example, in the paper [Yang et al, 2008 J Zhejiang Univ Sci B 9(12) 996-1002] Lorentzian approximation is applied to fit LSF data. Obtained value of □=11.9±3.3 arcmin corresponds to k from 0.45 to 0.8 arc deg. Thus the entire spatial frequency range of visual system appeared to be wider than its optical part! Clearly this contradiction calls for further investigation.

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m

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The influence of the illumination geometry and luminance contrast on gloss perception

F B Leloup[1,2], M R Pointer[3], P Dutré[2], P Hanselaer[1,4] ([1]Light & Lighting Laboratory, Catholic University College Sint-Lieven, Belgium; [2]Computer Graphics Research Group, KU Leuven, Belgium; [3]Dept of Colour Science, University of Leeds, UK; [4]Dept of Electrical Engineering (ESAT), KU Leuven, Belgium; e-mail: frederic.leloup@kahosl.be)

Gloss is one of the main characteristics that determine the appearance of an object. Physically, gloss results from directionally selective light scattering at the front surface of a material, with a preference towards the specular reflection direction. However, the sample illuminance and consequently the entire luminance distribution of the illumination scene around the sample could strongly influence gloss perception, especially for high glossy surfaces on which a reflected image becomes perceptible. The rear side of three flat glass samples was respectively painted white, grey and black, approximately resulting in equal steps in lightness. A light booth comprising two tunable light sources was designed. The mirror image of only one light source was visible in reflection by the observer. By separate adjustment of the intensity of both light sources, the luminance of the reflected image and the adjacent surroundings could be individually varied. Ten observers rated the glossiness of each of the three samples twice for sixty-five di_erent illumination settings, using magnitude estimation. A psychophysical scaling function that relates visual gloss perception to the luminance of the reflected image and the o_-specular surround was derived with least squares fitting techniques. The observer accuracy and reliability were evaluated by the coe_cient of variation.

POSTER SESSION: EYE MOVEMENTS II

m

34

Adaptation of oculomotor IOR to the environmental statistics through sequential updating of expectations

C J H Ludwig, S Farrell (Dept of Experimental Psychology, University of Bristol, UK; e-mail: c.ludwig@bristol.ac.uk)

In a recent study Farrell et al (2010 PNAS 107 929-934) showed that the magnitude of oculomotor inhibition of return scales inversely with the likelihood that a previously fixated location will become behaviourally relevant. We present a model for learning the local, nonstationary statistics in the context of sequences of saccadic eye movements. The generation of a saccade is modelled as a race to threshold between multiple competing movement programmes. A bias against returning to a previously fixated location is instantiated by a reduced accumulation rate associated with the return location, which is independent of the local statistics. The starting point of accumulation represents the subjective 'prior' belief that a given location will become the target for the next saccade. These priors are updated so that movement programmes consistent with recent experience are selectively facilitated, as are programmes

that have come to be associated with some contextual cue. This sequential updating model provides a good account of a large body of data from experiments in which we periodically varied the probability that return saccades were called for. It provides a functional explanation for the variability in starting point that is typically treated as noise in models of decision-making.
[Supported by The Wellcome Trust (079473/Z/06/Z) and EPSRC (EP/E054323/1)]
Poster session: Eye movements II
Thursday
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m
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The accuracy of ultra-rapid saccades to faces
M A Mathey, S M Crouzet, S J Thorpe (Cerco, CNRS Université Toulouse 3, France;
e-mail: marie.mathey@gmail.com)
When two photographs are presented in the left and right visual fields, reliable saccades towards face targets can be initiated in as little as 100–110 ms (Crouzet et al, 2010 J Vis). There is increasing evidence that information in the Fourier spectrum may play an important role in producing this early face bias (Honey et al, 2008 J Vis; Crouzet and Thorpe, 2010 VSS). To explore the limits of such low-level strategies we investigated the accuracy of saccades to small face targets (roughly 30 pixels across) located within a highly varied set of photographs of natural scenes. The original images were cropped (566×566 pixels) so as to o_set the face from the centre in 8 possible directions and at 2 di_erent distances (roughly 8° and 16°). The results showed that even rapid saccades with latencies below 150 ms could be remarkably accurate: for most such saccades directional error was <10° although there was a marked tendency to undershoot the target. The results fit with previous work using animal targets (Drewes et al, 2008 Perception 37 ECVP Supplement, 160), and demonstrate that although the underlying face detection mechanisms may use relatively low-level diagnostic features, they must nevertheless be remarkably location specific.
[Supported by the DGA and the CNRS]
m
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Transfer of visual predictions across hemispheres
P Vetter, G Edwards, L Muckli (Dept of Psychology, University of Glasgow, UK;
e-mail: p.vetter@psy.gla.ac.uk)
We investigated how visual predictions as elicited by apparent motion are transferred across hemispheres. Subjects viewed an apparent motion stimulus and detected briefly flashed targets on the apparent motion trace, with some targets appearing in time with the illusory motion token and some targets appearing out of time with the token. In previous studies, we showed that in-time targets are detected better than out-of-time targets, indicative of a spatio-temporally specific prediction signal in V1. In this version of the experiment, we asked subjects to rhythmically saccade across the apparent motion stimulus such that the predictive signal had to be remapped across hemifields. Thus we were able to investigate the predictive detection advantage of in-time targets relative to the time of saccade. We found that the predictive signal disappeared after saccade cue and recovered within a time window of 50–100 ms after saccade o_set. These results show that visual predictions elicited by apparent motion reformulate in the opposite hemisphere very shortly after an inter-hemifield saccade.
[Supported by BBSRC]
m
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Revision of the micromovement's role in the organization of vision process
A Kirpichnikov (Institute of Control Sciences, Russian Academy of Sciences, Russia;
e-mail: kinga127@yandex.ru)
The results of experiments we conducted using a specially designed high-sensitivity eye-tracking system allow us to advance the following hypothesis: when viewing an object the eye forms its image via specialized areas—microunits—of the retina which respond to certain characteristic features of the image convenient for encoding. The collections of microunits are distributed in the retina to act as the set of filters for image processing. At the same time the process of scanning is linked with control of accommodation. Together with the retina's layers curvature, it provides an additional possibility of tuning the system by means of micromovements of the optical axis and di_raction pattern analysis. In addition to the crystalline lens, the vitreous body—its optical properties are controlled by muscle mechanics and intraocular pressure—plays an important role in accommodation and retinal image formation. The above considerations lead to the concept of 'accommodation profile' that explains accommodation lag and some other phenomena. We do not treat the eye micromovements as a stochastic process but as a process correlated with the sustained accommodation profile and algorithm-specific topology of the retina's current state adjusted to the type of the object or to the task (detection, recognition, etc).
m
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A spatial dissociation between stimulus location and movement endpoint for express-like saccadic eye movements

J A Edelman, Z Fishman (Dept of Biology, City College of New York, USA;
e-mail: jedelman@ccny.cuny.edu)
Edelman and Xu (2009) examined how visual stimulus appearance can disrupt voluntary saccade commands. It showed that visual distractors briefly (30–50 ms), but almost completely, inhibit horizontal saccades that were planned to be made to a location distant from the distractor, but immediately

(with latencies in the express saccade range) elicit saccades planned to locations close to the distractor. Interestingly, when a distractor was close to the saccade goal, these express-like saccades were apparently triggered by the distractor, but were executed to a location much closer to the saccade goal. Here, we further explored this latter phenomenon. Saccades were made to memorized locations on or slightly above or below the horizontal meridian. The disappearance of a central fixation arrow, indicating the saccade direction, cued saccade initiation. For all saccade goal locations, distractor presence only marginally e_ected on saccade vector, though this e_ect increased slightly with saccade goal elevation. In all cases distractor e_ect was small even if saccades had express-like latencies (80–110 ms) relative to the distractor, and thus seemed to be triggered by distractor appearance. This spatial dissociation is quite surprising given that express saccades are thought to be triggered immediately by the visual response in the superior colliculus.
[Supported by: NIGMS GM00816-29/30 (SCORE) and 5G12 Rr03060 (RCMI)]

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Pictures speak louder than words: Saliency e_ects in paintings
I M Fuchs, U Ansorge (Dept for Psychological Basic Research, University of Vienna, Austria;
e-mail: isabella.fuchs@univie.ac.at)
Saliency models [eg Itti and Koch, 2000 Vision Research 40(10-12) 1489-1506] investigate the link between bottom-up factors and attention. These models predict where our gaze is drawn to in an image by means of local feature contrasts of colour, intensity and orientation. In the present study we investigated how well these predictions work for abstract and depictive paintings, as well as for control conditions with photos. We found that observers' fixations were predicted better than chance by Itti and Koch's saliency model in all our conditions, when comparing gaze behavior to random distributions. Receiver operating characteristics (ROC) curves also indicate saliency e_ects in all stimulus categories, as well as a characteristic short-lived temporal profile of these e_ects in paintings. Results are discussed with respect to potential implications of our findings.

m
40
Do eye movements inform how a magic trick is understood?
P F Heard, L Ganatra (Dept of Psychology, University of the West of England, UK;
e-mail: priscilla.heard@uwe.ac.uk)
Participants were presented with video clips of four di_erent magic tricks which were performed either perfectly or with an error—giving cues as to how the tricks work. Each magic trick was presented with both versions either the perfect or erroneous first, which was repeated up to three times and the participant asked if they could say what the trick was and how it was done. Then the other version was shown and the same question asked. Participants' eye movements and verbal responses were recorded. It was found that repeated watching of the perfect magic trick if presented first led to guessing of how it was achieved. Seeing the erroneous version first produced some very clear descriptions of the trick which gave immediate understanding of the perfectly performed trick presented afterwards . Eye movements became more focused on the critical cues with repeated presentations, and some participants fixated the giveaway clues without immediately appreciating their significance.

m
41
Eye movements in the blind
T Rolf[1], K Rolf[2], N Galley[2], L K von Segesser[1] ([1]Dept of Cardiovascular Surgery, CHUV, Switzerland; [2]Dept of Human Sciences, University of Cologne, Germany;
e-mail: taninarolf@yahoo.com)
Objectives : Eye movements are necessary to stabilize the retinal picture and to find a new object. This seems useless for blind people, so why do they nevertheless have them.We report on an EOG study on 29 blind volunteers and 5 volunteers with closed eyes. Material and methods: We recorded eye movements by EOG and let the volunteers fulfill di_erent exercises by following an acoustic running point by gaze, pointing, imagining in the room, listing words that begin with the vocal U and a finger labyrinth. Results: We found slow eye movements as well as pathological eye movements in the blind subjects. We found that blind subjects have a horizontal preferency.The duration of fixation of pictures is shorter in the blind subjects. The blind could even modulate saccade amplitudes . Discussion: Eye movements seem to be structural properties of the brain which prepare the organism for certain situations—even if they do not take place. We think that eye movements are partially independent of the experience of view. We did not expect that the blind subjects could modify gaze according to the subject. This leads to the hypothesis of

a preformed dimensional system.
Poster session: Eye movements II
Thursday
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Larger stimuli do not attract more the gaze
C Tandonnet, D Massendari, F Vitu (Laboratoire de Psychologie Cognitive, CNRS, Université de Provence, France; e-mail: christophe.tandonnet@univ-provence.fr)
As suggested by several previous studies, stimuli which are greater in size more easily capture attention. They also more easily deviate the eyes from their target location, as attested by the well-known tendency of moving the eyes towards the center of gravity of the visual configuration (Findlay, 1982 Vision Research 22 1033-1045). Here, we reexamined the influence of stimulus size on saccade metrics by varying stimulus size along one single dimension (the vertical) for the case of horizontal saccades. The saccade-target stimulus, a small circle of constant size (0.2°), was presented at variable eccentricities on the horizontal axis, with or without a nontarget stimulus. The distractor, a thin (one-pixel wide) vertical line whose length was systematically manipulated (0.3–4°), was presented between the initial fixation stimulus and the target. Results showed that the two shortest vertical lines (less than 2°) significantly deviated the eyes away from the target, with the longest of the two producing the greatest deviation. However, as the distractor line became longer (between about 2 and 4°), the e_ect reversed. More than challenging the e_ect of stimulus size, the present findings raise the possibility that the location of stimulus boundaries and/or line ends is more critical for specifying saccade metrics than stimulus size per se.
m
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Parallel processing in a sequential task: Evidence from eye movements
H A Trukenbrod, R Engbert (Dept of Psychology, University of Potsdam, Germany; e-mail: Hans.Trukenbrod@uni-potsdam.de)
Current models of eye-movement control are derived from theories assuming serial processing of single items or theories based on parallel processing of multiple items at a time. This distinction has persisted because of the investigated paradigms in which serial and parallel models reproduce experimental data equally well. Here, we study eye movements in a sequential scanning task as a conservative test of serial processing. We investigate whether eye-movement control switches into a purely serial mode when the task necessarily requires serial order of processing. Our analysis of skipping saccades and measures of distributed processing provides evidence against models based on serial attention shifts. We conclude that our results lend support to parallel processing as a default strategy for eye-movement control.
[This research was supported by Deutsche Forschungsgemeinschaft (DFG, grant no. EN471/1-2)]
m
44
Contrast e_ects on velocity integration for saccades to moving targets
P J Etchells, C P Benton, C J H Ludwig, I D Gilchrist (Dept of Experimental Psychology, University of Bristol, UK; e-mail: peter.etchells@bristol.ac.uk)
Under normal viewing conditions, successfully tracking a moving target requires that the eyes first perform an accurate 'intercepting' saccade. Previously, we have shown that in planning a saccade to a moving target, the system keeps track of a rolling average of the target velocity during the latency period. Given that the perceived speed of an object (Thompson, 1982 Vision Research 22 377-380) and saccade latency (Ludwig et al, 2004 Vision Research 44 2597-2604) are both a_ected by target contrast, here we investigate whether contrast has an e_ect on the temporal motion integration window used when generating saccades to moving targets. Participants were presented with Gabor patches at one of four contrasts, moving at 18 deg/s. A fixation point change signalled which patch to saccade to. In 50% of the trials, the patches either step up to a faster (30 deg/s) or down to a slower (6 deg/s) speed at a variable time after the go signal. Data analysis shows a temporal shift in the integration kernel peak, with decreasing contrast resulting in delayed incorporation of the post-step speed into saccade planning. This suggests that contrast a_ects the latest point at which new velocity information is incorporated in the movement plan.
m
45
Scanning modes di_er between beauty and roughness judgments
R H A H Jacobs[1,2], R Renken[1,2], F W Cornelissen[1,2] ([1]Laboratory for Experimental Ophthalmology, University Medical Center Groningen, The Netherlands; [2]BCN NeuroImaging Center, University of Groningen, The Netherlands; e-mail: r.h.a.h.jacobs@med.umcg.nl)
A previous finding of higher amygdala activation during beauty than during roughness judgments suggested attentional di_erences between these judgments (Jacobs et al., submitted). Interested in task-driven influences on eye-guidance, under circumstances where the relevant information overlaps spatially, we investigated eye movements accompanying these two judgments about visual textures. Participants judged textures for beauty and roughness, while their gaze-behavior was recorded. Fixations

lasted longer during roughness judgments. As fixation duration reflects the di_culty of information

extraction, our results suggest that feature extraction is easier for beauty judgments. In addition, we argue that di_erent scanning modes are employed during the di_erent judgments, based on a report that fixation durations appear to be adjusted slowly, over multiple fixations [Hooge and Erkelens, 1998 Vision Research 38(9) 1295-1302]. Together, these findings elucidate task-driven e_ects on scanning modes, even when the required information overlaps spatially. We speculate that our findings may generalize to evaluative versus descriptive judgments in general.
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m
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Influence of center-of-pressure movements on fixational eye movements
K Mergenthaler, R Engbert (Dept of Psychology, University of Potsdam, Germany;
e-mail: mergen@uni-potsdam.de)
Saccadic and smooth pursuit eye movements can be induced by large passive or active body movements, eg via vestibulo-ocular and opto-kinetic reflexes. For fixational eye movements no clear link to small postural movements, ie center of pressure movement, has been established. Nevertheless, the link is expected to play an important role in retinal image stabilization, one of the major functions suggested for fixational eye movements. Here we present evidence for a temporal coupling of fixational eye movements and center of pressure movements. Simultaneous data recordings of center-of-pressure movements and fixational eye movements were acquired during quiet standing and fixation of a tiny dot on a computer screen. Shifting the time series against each other allows the investigation of temporal patterns in the coupling. The observation suggest a visually guided compensatory mechanism in fixational eye movements for postural sway.

m
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On the relationship of viewing task, eye movements and the modes of visual processing
M C Cölln, J R Helmert, B M Velichkovsky (Institute of Psychology III, Technische Universität Dresden, Germany; e-mail: coelln@psychologie.tu-dresden.de)
Eye movements are often understood as being an overt manifestation of covered processes occurring ‘behind the scenes’ of visual perception. Recent evidence has been reported, that the interplay of dorsal and ventral visual pathways (eg Milner and Goodale, 1995 The Visual Brain in Action Oxford University Press) is associated with changes in parameters such as fixation duration and saccadic amplitude (Velichkovsky et al, 2005 Proceedings of the XXVII Conference of the Cognitive Science Society 2283-2288). The present experiment consisted of three blocks, showing images of abstract computer-generated scenes containing simple geometrical objects. Before each block subjects were either asked to attend to details of objects (focal processing), their spatial layout (ambient processing), or both of them. The experimental paradigm allowed varying the color, shape and position of objects while eliminating other interfering factors such as size and quantity of image components. Fixation durations, saccadic amplitudes, and their interplay in the time course of inspection were investigated. Additionally, we analyzed di_erences in the spatial distribution of gaze. Preliminary results show that all considered measures are influenced by viewers’ intention. This further supports the idea of a dynamic balance in the modes of visual processing and its relation to eye movements.

POSTER SESSION: ILLUSIONS

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Visual capture and the experience of having two bodies
L Heydrich[1,2], J E Aspell[1], B Herberlin[1], O Blanke[1,2] ([1]Laboratory of Cognitive Neuroscience (LNCO), École Polytechnique Fédérale de Lausanne (EPFL), Switzerland; [2]Dept of Neurology, University Hospital, Geneva, Switzerland; e-mail: lukas.heydrich@epfl.ch)
The experience of singularity of the conscious self may break down in heautoscopy. In heautoscopy patients see a double or doppelganger of themselves. Moreover, the self may be experienced as reduplicated—existing at two or even more locations simultaneously (Blanke et al, 2004 Brain 127 243-258). Using head-mounted video display, self-location (where participants experience their self to be localized) and self-identification (identifying with a fake body) can be manipulated by applying conflicting visuotactile information (Lenggenhager et al, 2007 Science 317 1096). Yet the experienced singularity of the self was not a_ected, ie participants did not experience having multiple bodies. Here we investigated self-location and self-identification while participants (N=19) saw two fake bodies that were stroked either synchronously or asynchronously with their own body. We report that self-identification with two fake bodies was stronger during synchronous stroking and that self-location—measured by anterior posterior drift—was significantly shifted towards the two bodies in the synchronous condition

only. Furthermore, synchronous stroking led to the feeling of having multiple bodies. We conclude that participants self-identify even with more than one fake body during congruent visuotactile stimulation and experience having more than one body, as seen in heautoscopy of neurological origin.

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Scintillating Neon Illusion

K Shiina[1], K Shinohara[2], T Fujii[3], M Takashima[4] ([1]Dept of Psychology, Bunkyo University, Japan; [2]Information Center, Dokkyo University, Japan; [3]College of Economics, Keiai University, Japan; [4]College of Humanities and Sciences, Nihon University, Japan; e-mail: shiina3@koshigaya.bunkyo.ac.jp)

When crossing portions of black line grid are replaced with red crosses, the reddish color spread is observed between red lines: the neon color e_ect. When red crosses are rotated some degrees to disconnect with the black lines, the neon color disappears. We report here two new observations relating to the neon color e_ect but in motion. (1) When red crosses are rotated in constant velocity, neon color will be observed only when red and black lines are connected but with slow velocity, suggesting that the neon color e_ect needs some processing time to develop the phenomenon. (2) In the second condition, the black crosses are not removed from the grid, and red crosses are rotated over them. When they are superimposed, red lines overwrite black lines. On observing this motion an amazing red flashing can be seen at the moment of superimposition. We named this phenomenon as Scintillating Neon Illusion. The flashing neon will be observed not only in rotation but also in transposition or in flickering replacement of red and black crosses. One of the parameters of the strength of the scintillating neon illusion is the total length of the superimposed lines. The underlying mechanism will be discussed.

[The Scintillating Neon Illusion earned the grand prize in the first Japan Illusion Contest, 2009]

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Perceptual filling-in of the blind spot: an fMRI study

D Alnæs[1], T Endestad[1], S Magnussen[1], M H Sneve[1], L Spillmann[2], J S Werner[3] ([1]Dept of Psychology, University of Oslo, Norway; [2]Brain Research Unit, University of Freiburg, Germany; [3]Dept of Ophthalmology, University of California, USA; e-mail: dag.alnas@psykologi.uio.no)

The mechanism of the perceptual filling-in of color, pattern and texture in the blind spot has been debated. Most authors assume a process whereby a representation of the missing information is created in the nonstimulated cortical area by signals from the surround. Spillmann et al. [2006 Vision Research 46(25) 4252-5257] found that filling-in requires just a small frame aligned along the blind spot border, 0.05° for color, and 0.2° for texture, suggesting a local edge e_ect. The site of this physiological process must be V1, which is the only cortical area where the blind spot is retinotopically represented (Tong and Engel, 2001 Nature 411 195-199). We have tested the hypothesis of a local, active physiological filling-in process combining psychophysics and brain imaging in a modification of the Spillmann et al (2006) experiment run in a 3T scanner. The preliminary results support the hypothesis.

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Illusory motion perception induced by failure to detect motion

H Ito (Faculty of Design, Kyushu University, Japan; e-mail: ito@design.kyushu-u.ac.jp)

A new figure that causes illusory motion perception was investigated. A colored disc was placed on the center of a circular area segmented by grey or white fan shapes forming a radial pattern. The disc was seen to move in the same direction as that of eye movement (1) when the disc was viewed in peripheral vision, (2) when smooth pursuit occurred (saccades did not cause the illusion), and (3) when the disc luminance was close to the averaged background luminance. Although a similar illusion was seen also when a uniform background was used, the e_ect was weak. A background consisting of parallel lines did not cause this illusion. This illusion is di_erent from the fluttering heart illusion caused by eye movement because (i) the present illusion is seen under strong illumination (even under direct sunlight), (ii) no phase lag of the illusory motion is perceived, and (iii) the illusory motion direction is opposite to that expected by the fluttering heart illusion. It is suggested that this illusion is caused by failure to detect retinal motion of the disc in spite of the existence of eye movement signals.

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m

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The e_ect of illusory contour and binocular disparity on the Ebbinghaus illusion

W H Jung, Y-W Lee (Dept of Psychology, Chungbuk National University, South Korea; e-mail: com4man@gmail.com)

To investigate the impact of illusory contour and binocular disparity on Ebbinghaus illusion, two types of Ebbinghaus figure were compared. One of Ebbinghaus figure was superimposed by Kanizsa's illusory square. In this figure, center circle was surrounded by packman tokens which were arranged to appear

illusory contour. The other was Ebbinghaus figure composed by packman tokens which were made

no illusory contour. According to experimental condition, the binocular disparities of surrounding packman tokens, illusory contour, and center circle were varied. The results showed that when the center circle was surrounded by illusory contour, the Ebbinghaus illusion was weaken than the other case. This tendency persisted in condition when the center circle and illusory square were in di_erent depth plane with inducing elements by binocular disparity. These results imply that illusory contour could a_ect perception of Ebbinghaus illusion and appearance of this illusion is independent with binocular disparity, though its occurrence could be related with the later visual information process.

m

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The Mona Lisa e_ect: 2D versus 3D

E Boyarskaya, H Hecht (Experimental Psychology, Johannes Gutenberg - Universität Mainz, Germany; e-mail: boyarska@uni-mainz.de)

Due to our ability to judge gaze direction of others we are capable to participate in everyday social interactions. One of the most exciting phenomena of gaze perception is the Mona Lisa e_ect, when the eyes of the portrait appear to 'follow' the beholder whatever vantage point he or she may assume. In our previous experiments we confirmed the Mona Lisa e_ect for portraits with straight-ahead look in horizontal, vertical and diagonal planes regarding picture displacement relative to the observer. For averted gaze directions, however, most observers over-rotated. Granted that humans are highly sensitive to gaze direction of others, we extended the experiment with virtual 3D heads, which had identical gaze directions (straight ahead, to the right, left, up and down) and view positions (straight ahead, shifted up, down, left, right or obliquely) as the 2D portrait faces. To test the hypothesis, that Mona Lisa and over-rotation e_ects are unique for picture perception, we asked the subjects to estimate the gaze direction of 2D and 3D heads in two experimental blocks. The perceptual distinction of the 2D and 3D gaze perception will be discussed.

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Representational-velocity of the subject after occlusion during position anticipation task

T Arai[1,2], K Fujita[1], M Takeichi[3] ([1]Graduate School of Engineering, Tokyo University of Agriculture and Technology, Japan; [2]Dept of Commercial Science, Takachiho University, Japan; [3]Faculty of Political Science and Economics, Kokushikan University, Japan; e-mail: takeyuki@takachiho.ac.jp)

We reported a drastic underestimation in the position anticipation task of an occluded moving object (Takeichi, 2005 Perception 34 ECVP Supplement, 231). The measured eye movement suggested the decrease of the representational-velocity after the occlusion (Takeichi et al, 2007 Perception 36 ECVP Supplement, 30). However, the reappearance time anticipation task after occlusion, similar to time-tocontact task suggested the accurately preserved representational-velocity after the occlusion. Therefore, we evaluated the representational-velocity of the object after occlusion. We displayed moving stripes at random velocities after the occlusion, and let 10 subjects compare those with the representationalvelocity of the moving object. The average velocity of the stripes those are subjectively equivalent to the representational-velocity was 8.1 deg/s, while the actual moving velocity was 10 deg/s. The anticipation velocity, calculated from the anticipated positions, was 3.1 deg/s. The results supported the accuracy of the representational-velocity of the object after occlusion. The position anticipation task requires the subjects to answer the anticipated object position using the scale on the stationary board when a visual stimulus is applied. It requires the subjects the attention to the stationary scale and the virtually moving object simultaneously. This divided attention may be the cause of the underestimation.

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m

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Illusory rotation of ambiguous figures in children and adults

S V Feoktistova[1], S V Dmitrieva[2], S G Hodyreva[2], A V Filippova[2] ([1]Dept of Psychology and Pedagogy, Russian New University, Russia; [2]School No 1273, Moscow Dept of Education, Russia; e-mail: svetdm@mail.ru)

Comparison of visual illusions in children and adults could help in understanding both related visual mechanisms and general age dynamics of perception and personality. In view of testing children, the illusion of ambiguous rotation has some advantages: the task is simple and detection of current changes in the stimulus interpretation can be performed via changes in the perceived direction of turning. We have studied illusory rotation of the ambiguous figures (human silhouette, Necker cube) in 3 age groups: 50 junior school children (aged 6–7 years), 100 adolescents (16–17 years) and 50 adults (45 years or more). A computer program for stimulus presentation was elaborated by A.Terekhin. Stimulus exposure time was 1 min, angular velocities were in the range 8–40 cpm. The subjects were tested individually

and the following data were registered: (1) the initial direction of perceived rotation (clockwise or anticlockwise); (2) the number of changing direction; (3) the occurrence of left-right oscillations instead of rotation. In adults, the first percepts were more persistent than in children. Junior school children

observed significantly more changes in direction of rotation than adolescents and adults (eg at 18 cpm, mean numbers were 2.4, 1.6, and 0.8, respectively).

m

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The e_ect of stimulus duration on the extinction illusion

Y Araragi[1], A Kitaoka[2] ([1]Global Innovation Research Organization, Ritsumeikan University, Japan; [2]Dept of Psychology, Ritsumeikan University, Japan; e-mail: uqar@fc.ritsumei.ac.jp)

We quantitatively examined the e_ect of stimulus duration on the extinction illusion. A white disc was presented or not presented at an intersection of a gray grid on a black background (intersection configuration) or on a homogeneous black or gray background (background configuration). The frequency that the extinction illusion occurred was defined as the di_erence between the frequency that the disc was not perceived in the intersection configuration and that in the background configuration. Experiment 1 showed that when the stimulus duration was over 1000 ms, the extinction illusion occurred more frequently as the stimulus duration increased. Moreover the extinction illusion occurred more frequently as the retinal eccentricity increased. Experiment showed that when the stimulus duration was 200 ms, the extinction illusion occurred more frequently in the upper visual field than in the lower visual field; there was no anisotropy, when the stimulus duration was 6000 ms. Experiment 3 showed that when the grid alley length was long, the extinction illusion occurred more frequently in the 6000 ms stimulus duration than in the 200 ms stimulus duration; there was no temporal e_ect, when the grid alley length was short. These results show that the extinction illusion is a_ected by the stimulus duration depending on spatial conditions.

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Aesthetic dimension of visual illusions

J Stevanov[1], S Markovic[2], A Kitaoka[1] ([1]Graduate School of Letters, Ritsumeikan University, Japan; [2]Faculty of Philosophy, University of Belgrade, Serbia; e-mail: jasminastevanov@yahoo.com)

The basic idea of this study was that visual illusions have dual nature: they are obviously perceptual phenomena, but along with this, they have certain aesthetic or a_ective dimensions. We investigated the e_ects of visual illusions on Aesthetic Experience (scales: fascinating, irresistible, exceptional) (Polovina and Markovic, 2006 Psihologija 39 39-55) and dimensions of Subjective perception of a form [Evaluation (pleasant, cheerful, clear, bright), Arousal (interesting, imaginative, complex, various), and Regularity (balanced, coherent, clear, realistic)] (cf. Markovic et al, 2002 Psiholoska istrazivanja 11/12 75-112). Two sets of stimuli were generated—illusory and non-illusory visual patterns. Illusory stimuli included visual patterns with highest possible intensity of illusory e_ect, while non-illusory stimuli referred to reduced intensity or non-existence of illusory e_ect. The results revealed that illusory stimuli were judged significantly higher than non-illusory stimuli on dimensions Evaluation, Arousal, and Aesthetic Experience. Multiple regression analysis has shown that Arousal was a better predictor of Aesthetic Experience than Evaluation. These findings suggest that Aesthetic Experience of visual illusions is closer to the curiosity and non-homeostatic motivation than to hedonic tone, which is in line with Berlyne's arousal theory of aesthetic preference (Berlyne and Ogilvie, 1974 Studies in the New Experimental Aesthetics Hemisphere, Washington, DC).

m

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The ability of haptics to modulate the Ebbinghaus Illusion

T Mochizuki (Japan Women's University, Japan; e-mail: motizuki@fc.jwu.ac.jp)

Purpose: We investigated how the Ebbinghaus Illusion could be modulated by haptics. Method: Ten university students observed the illusory figure under visual and bimodal conditions. Illusory figures composed of a central circle (5 cm in diameter) and five surrounding circles (3, 4, 5, 6, or 7 cm in diameter, size D) were presented one by one on a PC display. In the bimodal condition, the observers had to integrate the sizes of the visual and haptic central circles, which were congruent or incongruent in size. They simultaneously explored the haptic circle presented on the other side of the visual image by hand. Then, they decided the apparent size of the central circle among the comparison stimuli (4, 4.5, 5, 5.5, and 6 cm in diameter). Results: (1) In the visual condition, the Ebbinghaus Illusion could be clearly found. The PSE (subjective equal size of the central circle) was larger than 5 cm when D=3 cm, while it was smaller than 5 cm when DC4 cm. (2) In the bimodal condition, haptics modulated the amount of size illusion. The mean error score (PSE: 5 cm) of each central circle was significantly decreased by the haptic capture.

m

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The e_ect of binocular integration on scintillating bar illusion

K Qian[1], T Kawabe[2], Y Yamada[3], K Miura[3] ([1]Graduate School of Human-Environment, Kyushu University, Japan; [2]Institute for Advanced Study, Kyushu University, Japan; [3]Faculty of

Human-Environment, Kyushu University, Japan; e-mail: qk@kyudai.jp)
Anomalous dark spots are illusorily perceived within white disks placed at the intersections of orthogonal gray bars on a black background (scintillating grid illusion). Similarly, illusory spots were perceived within the disks placed either on horizontal or vertical bars (Scintillating bar illusion; Qian et al, 2010): It has been reported that the strength of this illusion was weaker than the scintillating grid illusion. The present study tried to clarify whether binocular integration of dichoptically-presented horizontal and vertical bars produced the illusion as strong as scintillating grid illusion. Stimulus conditions, including binocular grids, monocular grids, binocular bars, dichoptic bars and monocular bars, were used in the experiment. The result showed when horizontal and vertical bars were dichoptically presented, the illusion was weaker than that in other grid conditions, indicating that dichoptic orientations are not integrated to promote the illusion, and thus scintillating grid illusion depends on orientation processing in the monocular pathway. Moreover, for grid conditions, binocular presentation produced the stronger illusion than monocular presentation. The results suggest that binocular integration of luminance information a_ects the magnitude of the illusion.
[Supported by Japan Society for the Promotion of Science]

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The strength of geometrical and lightness illusions in 2D–3D configurations

G Y Menshikova, E G Lunyakova, N V Polyakova (Dept of Psychology, Lomonosov Moscow State University, Russia; e-mail: mgja@rambler.ru)
We investigated the strength of visual illusions in 2D–3D configurations. The Müller-Lyer illusion (MLI), simultaneous lightness contrast (SLC), and the Vasarely illusion (VI) were used. Stereo pairs of original illusions were presented in 2D (disparity=0) and 3D (4 values of disparity) configurations using HMD technique. In MLI the positions of wings were changed: their ends were moved in/out of the background forming convex/concave corners in 3D images. In SLC three configurations were formed: test patches were (A) moved out of the background being coplanar with it; (B) located at the same vertical angle to the background; (C) located at di_erent angles to it. In VI nested squares were moved in/out forming tunnel/pyramid configurations. 25 naive subjects were tested. For the estimation of the illusory e_ect the method of constant stimuli was used. Our results showed that the strength of MLI decreased for 3D configurations asymmetrically (stronger for concave corners). SLC weakly depended on A, B variants of 3D configuration and changed for C variant. The strength of VI increased for the pyramid form. So, the strength of the illusory e_ect changed in di_erent ways for the 3D configurations of studied illusions.
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The Fraser illusion family and the corresponding motion illusions

A Kitaoka (Dept of Psychology, Ritsumeikan University, Japan; e-mail: akitaoka@lt.ritsumei.ac.jp)
It is demonstrated that the Fraser illusion (Fraser, 1908 British Journal of Psychology 2 307-320), known as one of the classic tilt illusions or as the name of ‘twisted cords’, is a member of the ‘Fraser illusion family’, which includes of six types of tilt illusions. In the family, there are two factors to classify the six illusions. One is whether inducers are obliques or ‘shifted horizontals’. The other is whether inducers are only lines, only edges, or mixture of lines and edges. When inducers are oblique lines, the Fraser illusion appears. When inducers are oblique edges, the image shows the illusion of oblique edges (Kitaoka, 2007 Japanese Psychological Research 49 7-19). When inducers are made up of oblique lines and edges, the ‘Café Wall Fraser’ illusion (Fraser, 1908) is obtained. In contrast, when inducers consist of horizontal lines and edges, the ‘Fraser Café Wall’ illusion (Fraser, 1908) is shown. When inducers are shifted lines, the illusion of shifted lines (Kitaoka, 2007) appears. When inducers are shifted edges, the illusion of shifted edges (Kitaoka, 2007) is observed. A close relationship between this family of geometrical illusions and a series of motion illusions including reversed phi is discussed.

m

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The slant illusion: how grouping and perception depend on the viewing angle

L Sugano (Human Science, Takachiho University, Japan; e-mail: sugano@takachiho.ac.jp)
In the slant illusion, six squares are displayed in a row. Each of these squares contains two smaller squares. Two orthogonal lines cross through each square. Viewed frontally, squares look like pyramids viewed from above. When the figure is rotated by 90 degrees clockwise and then viewed from an acute

(about 45 deg) angle, perception and grouping of the elements have changed largely. Six successive and connected lines are perceived amodally completed. Simultaneously, five striped diamond shapes are perceived on the foreground.

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Why does the figure of humans look fatter on a TV screen or a photograph?
M Idesawa (Museum of Communications, University of Electro-Communications (UEC), Tokyo, Japan; e-mail: idesawa@is.uec.ac.jp)
Humans on a TV screen or a photograph look fatter than in the real world or on stereograms. This e_ect was investigated optogeometrically in connection with the binocular unpaired regions (BURs) on an object. In the stereogram, the BURs, only the paired parts might be perceived as the width of an object; while on a TV screen the BURs are embedded as imperceptive form and might increase the width. That is, the visual angle including BURs is wider than that of only the paired parts. This seems to be a good reason why fattening is observed on a TV screen. The author tested a stereogram of a cylindrical object model with and without BURs and found that the visual angle of the BURs (<1.5%) seems smaller than expected given the fattening e_ect. Hence, other factors seem to be involved. We know that the BURs on an object play an important role in volume perception (Idesawa et al, 1997 Perception 26 ECVP Supplement, 40; Watanabe et al, 2001 Journal of Appl. Physics 40 L958-L960); hence the lack of volumetric perception might contribute to the fattening e_ect.

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A perceptual motion compromise: the Unchained-Dots illusion
S Gori[1], E Giora[2], D A Stubbs[3] ([1]Dept of General Psychology, Center of Cognitive Sciences, University of Padua, Italy; [2]Dept of Psychology, University of Milan-Bicocca, Italy; [3]Perceptual Stu_ Organization, University of Maine, USA; e-mail: simone.gori@unipd.it)
A new motion illusion based on dot-trajectory misperception is presented. The pattern consisted in a dot matrix with variable horizontal gaps between elements.Watching this pattern scrolled up and down, with central fixation, observers reported a diagonal expansion motion of the dots when the matrix stimulus was going up and a contraction when was going down, although the physical trajectory of each dot was just vertical. The illusory e_ect can not be explained by the aperture problem in opposition to some previous illusions characterized by misperception of motion direction. We propose an explanation in terms of 'perceptual compromise' between an original type of apparent motion and the veridical motion.

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On the role of amodal completion in inducing size e_ects and shape distortions: The square/rectangle and the discontinuity illusions
B Pinna, M Tanca (Dept of Architecture, Design and Planning, University of Sassari, Alghero, Italy; e-mail: baingio@uniss.it)
Amodal completion occurs when a portion of an object is hidden due to its occlusion behind another object. Under these conditions, the object perceived as occluded is seen as a unitary object, whose boundary contours amodally complete behind the overlapped modal object. Kanizsa (1979) and Kanizsa & Gerbino (1982) demonstrated some e_ects related to the amodal completion: shrinkage of the partially occluded figure; expansion of the modally visible parts of the same figure, increasing of color quantity of the partially occluded figure and shape distortions against the gestalt factors of simplicity, proximity and past experience. The aim of this work is to demonstrate that amodal completion is neither a necessary nor a su_cient factor in inducing the previous e_ects. This was accomplished through psychophysical experiments, whose stimuli where crucial instances disproving the amodal completion hypothesis and proving the role played by the directional symmetry of the element components of each stimulus pattern. Two new e_ects, which we called 'the square/rectangle' and 'the discontinuity illusions', further demonstrated the main role of the directional symmetry, considered as a principle of shape formation (Pinna, 2010).
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66

A perspective on the Ames window
R L Gregory[1], P F Heard[2], E Foster[2] ([1]Dept of Psychology, University of Bristol, UK; [2]Dept of Psychology, University of the West of England, UK; e-mail: richard.gregory@bris.ac.uk)
37 naive participants made observations of the well known Ames window [Ames, 1951 Psychological Monographs 65(7) whole no. 324]. which is trapezoidal in shape with painted shadows and continuously rotates. Observations were also made of an identical trapezoidal window without the shadows and a non-perspective rectangular window with shadows—viewed at 4 meters, 1 meter, and half a meter with

one and two eyes. We found, as did Ames, that the trapezoidal shape produced a strong illusion of alternation of direction, irrespective of the shadows particularly if viewed from the long distance with one eye. When the trapezoid windows were perceived as alternating the point at which the window appeared to change direction was the same in all participants and was determined by the relative sizes of the sides of the window. At closer distances a few participants observed a dramatic shape change. The rectangular window was also seen to alternate in 10 participants, but only if they had previously viewed

a trapezoid window. These last two findings were not reported by Ames.

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Textural characteristics at the basis of the filled-space illusory enlargement

E Giora[1], S Gori[2] ([1]Dept of Psychology, University of Milan-Bicocca, Italy; [2]Dept of General Psychology, Center of Cognitive Sciences, University of Padua, Italy; e-mail: enrico.giora@unimib.it)

According to the Oppel-Kundt illusion, a filled-space appears bigger than an empty one of identical physical extension. Previous investigations have shown that specific combinations of the filling subparts critically a_ect the illusory area enlargement. Adopting a quantitative approach, we studied how textural characteristics a_ect the perceived size of two-dimensional patterns. We tested the perceived size of square textures entirely filled by micro-structural square elements. In accord with the adjustment method, test stimuli were compared to a uniform grey square varied in size, leading to a direct quantification of the illusion. An illusory increment of area extension was generally found with textured stimuli. In particular, areas perceptually expand with the increment of spatial frequency and the decrement of the subparts' number. Those results demonstrate the influence of image statistical properties on perceiving the size of a visual object.

POSTER SESSION: PERCEPTION AND ACTION II

m

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How does displacement and velocity reliability a_ect spatial and temporal interception errors?

C de la Malla[1], J López-Moliner[1,2] ([1]Vision & Control of Action Group, Dep. de Psicologia Bàsica, University of Barcelona, Spain; [2]Institute for Brain, Cognition & Behaviour (IR3C), University of Barcelona, Spain; e-mail: c.delamalla@gmail.com)

When hitting moving targets, we have two kinds of errors: the spatial error (the di_erence between where the target is and where subjects hit) and the temporal error (the time di_erence between the target and the hand at the intended hitting position). In our task we wanted to observe how these errors (accuracy) and their variability (precision) are a_ected by the manipulation of the reliability of di_erent sources of information: velocity and displacement. In di_erent sessions subjects had to hit moving targets under harmonic motion with either reliable displacement amplitude or reliable maximum velocity. We found no di_erence in spatial accuracy between the two conditions. In both conditions spatial variability increased with target peak velocity at a similar rate. However, a closer look at this trend indicates that spatial precision was always larger when displacement, rather than velocity, was reliable. Unlike spatial accuracy, temporal accuracy was larger when the displacement was reliable. Finally, the temporal precision increases with velocity only when displacement is reliable. We conclude that although both sources of information are related, displacement and velocity have di_erent e_ects on spatial and temporal errors.

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Action prediction in competitive table tennis

S Streuber, S de la Rosa (MPI for Biological Cybernetics, Eberhard Karls University, Tübingen, Germany; e-mail: stephan.streuber@tuebingen.mpg.de)

The direct matching theory proposes that the mere observation of an action performed by a human body activates the observer's motor system by means of a direct action–perception link (eg mirror neurons). As a result the observer can simulate the observed action within the own motor system in order to understand and predict the observed actions. Because action understanding and prediction are important mechanisms for action coordination in social interactions, social interactions should benefit from a direct matching mechanism. We predicted that seeing human body information (which provides action information) during a social interaction should improve social interaction performance. We tested this hypothesis in a competitive table tennis task in which participants played in complete darkness with only the ball, net, and table painted visible by means of self-glowing paint. We manipulated the visibility of the individual players' body and racket separately by placing self-glowing paint on the respective

items while measuring each player's error rate separately. Participants' performance improved when they saw the other player's body and racket. These findings illustrate the capacity of humans to integrate information about others actions and support the idea that direct matching mechanisms might support social interactions.

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The role of motor action in temporal order judgments

X Corveleyn[1], J López-Moliner[2], Y Coello[1] ([1]URECA, Université Lille Nord-de-France, France; [2]Institute for Brain Cognition and Behavior (IR3C), University of Barcelona, Spain;

e-mail: xavier.corveleyn@univ-lille3.fr)
When perceiving a single visual object, the binding of its di_erent physical properties (eg. colour, shape, motion) must take into account the di_erential processing delays. Consequently, temporal order judgments (TOJ) of changes of two object dimensions often give rise to the perception of an asynchrony even when the changes occur synchronously. If self-generated sensory events are processed earlier than when generated externally (Haggard et al, 2002 Nat Neurosci), one might expect that motor actions could a_ect TOJ between attributes. We studied the e_ect of a manual reaching movement on the temporal order judgments between changes of position and color of a visual target. TOJ were reported while performing the manual reaching task or in a perceptual condition. In the latter, we obtained a perceived asynchrony of 30 ms between the color and position change (position was perceived earlier). In the reaching condition, this asynchrony was broadly reduced. This result suggests that the signals associated with the organization of a motor action can facilitate the binding of perceptual dimensions of a single object.

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Hand dominance and the a_ordance e_ect: The same di_erence?

R C Ludford, M J Riddoch, G W Humphreys (Behavioural Brain Sciences, School of Psychology, University of Birmingham, UK; e-mail: rcl202@bham.ac.uk)

Tucker & Ellis (1998 Journal of Experimental Psychology: Human Perception and Performance 24 830-846) show e_ects of motor a_ordance based on congruity e_ects between hand of response and orientation of the handle of a tool. We were interested to see whether similar motor a_ordances might be observed with pairs of objects oriented for action and whether e_ects might be modulated by dominance of responding hand. Left and right-hand dominant participants viewed pairs of objects that were or were not correctly oriented for action, presented either simultaneously or sequentially with a varying interstimulus interval (ISI) and were asked to respond with either their dominant or non-dominant hand. When stimuli were presented simultaneously, all participants showed an e_ect of correctly co-locating objects for action. When there was an ISI no e_ect of action-relation was observed, instead RTs were faster to tools congruent with the dominant hand of the participant. Both e_ects were modulated by dominance of responding hand, and whether the participant was left or right handed. The data suggest that action-related e_ects on visual processing can have two components - a visual 'a_ordance' when objects are co-located for action and a motor a_ordance based on the location of an object in relation to the hand the participant would normally use for the response.

[RL is funded by the ESRC]

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Perception of causality between observer's action and environmental event

A Sakai (Dept of Psychology, Meisei University, Japan; e-mail: a_sakai@psy.meisei-u.ac.jp)

In most psychological experiments, observers perceive various relations, including causality, between visual/auditory events. In such experiments, participants, as a third person, only see or listen events. On the other hand, in everyday life, we also directly perceive the causality between the action made by ourselves and the following changes occurred in the environment. For example, 'Since I turned the switch, the light went on.' In this study, participants were asked to stop the alarm generated repetitively by the computer without instruction for operating to stop it. All the participants spontaneously clicked the mouse button. The alarm ceased, according to experimental conditions, dependently or independently of the clicking. Participants were asked to rate the clarity of relation between the clicking action and the cessation of alarm by 5-point scale. Independently of the spontaneous clicking was the prerequisite for cessation of alarm or not, the obvious causality was perceived between the clicking and the following cessation under all the conditions. The perception of relation through observer's action may therefore be regarded as a necessary component of operant behavior. This type of perception may also be regarded as perception of a_ordance, the possibility o_ered by the environment.

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The role of gravity in the combination of visuo – proprioceptive inputs for motion planning

A Sciutti[1], L Demougeot[2], B Berret[1], T Pozzo[1,2] ([1]Robotics, Brain and Cognitive Sciences Dept, Istituto Italiano di Tecnologia, Italy; [2]INSERM U887, Université de Bourgogne, France; e-mail: alessandra.sciutti@iit.it)

In everyday life gravity is determinant, as its mechanical e_ect on the moving limbs must be integrated to obtain dexterous arm movements (Gentili et al, 2007 Neuroscience 145 20-32). However, little is known about how di_erent modalities interact with the gravity-related mechanisms adopted in motion planning. This study investigates how vision and proprioception are combined in the planning of arm movements performed in the cardinal orientations. Ten subjects realized horizontal and vertical pointing movements while observing a rotated visual feedback of their motion: a vertical movement could for instance be associated to a horizontal visual feedback and vice versa. Even though the conflict between

modalities was explicit, the recorded movement timing (velocity profiles) reflected an influence of both visual and proprioceptive inputs. Moreover, a modality aspecific e_ect of verticality was present. In fact, when one of the two feedbacks, either visual or proprioceptive, was vertical the relative weight of the corresponding modality increased on average of about 25%. We suggest therefore that gravity plays a fundamental role in the combination of multimodal inputs for movement planning. Thus, a possible involvement of the vestibular sense cannot be disregarded in future studies of visuo-proprioceptive integration for three dimensional motion planning.

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Examining the interplay of tactile suppression and tactile attention during the execution of reach-to-grasp movements

G Juravle[1], H Deubel[2], C Spence[1] ([1]Crossmodal Research Laboratory, Experimental Psychology, University of Oxford, UK; [2]Dept of Psychology, Ludwig-Maximilians-University München, Germany; e-mail: georgiana.juravle@psy.ox.ac.uk)

Hand reaches are characterized by a decrease in tactile sensitivity in the hand that moves. In the present study, we investigated whether directing attention toward the moving or stationary e_ector results in di_erent patterns of tactile suppression. Participants performed a dual-task involving a goal-directed reach-to-grasp movement paired with a speeded response (RT) to a tactile pulse. The tactile pulse could be delivered to either the movement e_ector or to the resting hand, during one of three movement phases: Preparation, execution, or post-movement. Furthermore, tactile stimulation could be delivered with equal probability at either hand, with higher probability at the moving hand, or with higher probability at the resting hand. The results showed faster tactile RTs for higher probabilities of both movement e_ector and non-e_ector, as compared to the control condition, thus arguing in favour of an attentional account of sensory suppression. Moreover, a significant slowing of responses to stimuli delivered to the moving hand was found; as well as a linear decrease in RTs from the motor preparation period, through motor execution and finishing with the post-movement period, thus demonstrating an interplay between sensory suppression and attention. These results are discussed in the context of contemporary theories on sensory suppression.

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The relative precision of binocular and monocular cues to finger position determines their contribution to the online control of grasping

S J Watt, B D Keefe (School of Psychology, Bangor University, UK; e-mail: s.watt@bangor.ac.uk)

In normal grasping, removing binocular cues at movement onset produces an extended final 'slowmovement phase'. This may reflect a specialist role for disparity in providing information about the relative positions of the digits and the target object's surfaces. Alternatively, as cue-integration theory suggests, the contribution of binocular (and monocular) cues may depend on the precision of information available in a given instance.We varied the relative precision of online binocular and monocular feedback about hand position by varying the participants' viewpoint. In the 'normal' condition, the head was positioned so that, as the hand approached the object, the relative positions of the digits and the object di_ered primarily in the depth dimension. Here binocular disparity should provide more precise feedback than monocular cues. In the 'look-down' condition, participants looked directly down on the hand/object, so they were separated in the frontoparallel plane. Here monocular cues are highly informative, and disparity is not. In the normal condition, removal of binocular information resulted in an increased slow-movement phase. In the look-down condition, however, removal of binocular cues had no e_ect.

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These results are consistent with the idea that the relative precision of visual estimates from di_erent depth cues determines their contribution to online control.

[Supported by EPSRC and ESRC]

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Qualitative di_erences between fast response priming and the negative compatibility e_ect: Evidence for a motor memory component

T Schmidt[1], V Hauch[2] ([1]Dept of Psychology I, Faculty of Social Sciences, University of Kaiserslautern, Germany; [2]Dept of General and Experimental Psychology, University of Giessen, Germany; e-mail: thomas.schmidt@sowi.uni-kl.de)

In response priming, choice responses to a target stimulus are speeded or slowed by a prime triggering the same or alternative response, respectively. It has been shown that this priming e_ect can reverse at long stimulus-onset asynchronies (SOAs) between prime and target, especially when a mask occurs between prime and target onsets that carries response-relevant features ('negative compatibility e_ect'). We report experiments where speeded pointing movements are primed at long SOAs, with responserelevant, irrelevant, or no masks sandwiched between primes and targets. Large priming e_ects occur in the absence of a mask, irrelevant masks lead to a drastic reduction of priming, and relevant mask can

lead to a reversal of priming that is modulated by visual attention. In contrast to response priming at shorter SOAs where initial responses are controlled exclusively by the prime, reverse priming e_ects are controlled by a mixture of prime and target information. In addition, the onset time of the mask has no influence on the motor trajectory. We conclude that reverse priming e_ects at long SOAs, in stark contrast to regular e_ects at short SOAs, depend on a motor memory component.
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Reaching in the presence of threatening stimuli: Evidence for automatic avoidance
S Buetti, E Juan, D Kerzel (Faculté de Psychologie et de Sciences de l'Éducatiion, Université de Genève, Switzerland; e-mail: simona.buetti@unige.ch)
Anxious persons show dysfunctional threat detection that contributes to develop and maintain their disorders. While several studies confirmed the presence of automatic attention biases toward threat, no study investigated whether anxious disorders are also accompanied by automatic motor biases. In the present study, we investigated response selection and response programming processes of reaching movements in subclinical spider-fearful and non-anxious participants. Reaching responses were performed directly on the screen where stimuli were displayed. Participants had to reach with their index finger a left or right square located below the picture of a butterfly. A distractor (ie, the picture of a dragonfly, beetle or spider) was presented at the opposite location. Reaction times and the initial movement trajectories were evaluated. The results indicated that the two groups of participants had similar reaction times for all the distractors. On the other hand, we observed a modulation of response trajectories specific to threat: The initial movement trajectories of spider-fearful participants strongly deviated away from spiders.We suggest that this automatic motor avoidance of threat is the consequence of strong inhibitory processes that overcame activation at the threat location. The relationship between attention and motor biases are discussed in terms of models of motor control.

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Changing our perception of communication in virtual environments
T J Dodds, B J Mohler, H H Bültho_ (Dept of Human Perception, Cognition and Action, Max Planck Institute for Biological Cybernetics, Tübingen, Germany;
e-mail: trevor.dodds@tuebingen.mpg.de)
When people communicate face-to-face they use gestures and body language that naturally coincide with speech (McNeill, 2007 Gesture & Thought University of Chicago Press). In an immersive virtual environment (VE) we can control both participants visual feedback of self and the other in order to investigate the e_ect of gestures on a communication task. In our experiment the communication task is to make the listener say a word without the speaker saying the word. We use animated real-time self-avatars in immersive VEs to answer the question: "Does the use of naturalistic gestures help communication in VEs?". Specifically, we perform a within-subject experiment which investigates the influence of first- and third-person perspectives, and of animated speaker and listener. We find that people significantly perform better in the communication task when both the speaker and listener have an animated self-avatar and when the camera for the speaker shows a third-person perspective. When participants moved more they also performed better in the task. These results suggest that when two people in a VE are animated they do use gestures to communicate. These results demonstrate that in

addition to the speaker movements, the listener movements are important for e_cient communication in an immersive VE.

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The impact of action on perception: Evidence from ambiguous visual stimuli
K Fiehler[1], B M 't Hart[2], I A M Beets[1], D Y P Henriques[3], W Einhäuser[2] ([1]Experimental and Biological Psycholoy, Philipps-University Marburg, Germany; [2]AG Neurophysics, Philipps-University Marburg, Germany; [3]Centre of Vision Research, School of Kinesiology, York University, Toronto, Canada; e-mail: fiehler@sta_.uni-marburg.de)
While perception is inherently necessary for e_ective actions, some recent evidence suggests that action also shapes perception. Ambiguous stimuli inducing alternating perceptual experiences are a proper model to study the e_ect of action on perception without changing the visual input. Observers watched moving dots that are perceived as a cylinder either rotating clockwise or counterclockwise. In one condition, observers reported the perceived direction of motion with a keyboard while moving a manipulandum in an instructed direction (clockwise or counterclockwise). In the other condition, they moved the manipulandum congruently or incongruently to their perceived direction of motion. There was no visual feedback about the performed movement. We find that dominance durations are prolonged for the visual percept when its direction is congruently tracked with the manipulandum compared to incongruent tracking. In contrast, dominance durations do not di_er between congruent and incongruent movements when concurrent movements followed an instructed direction. Consequently, if action is

dependent on perception, it in turn influences perception directly, even when the visual stimulus is unchanged. This suggests that action and perception share common neural representations.
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POSTER SESSION: PERCEPTUAL ORGANIZATION

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Identification of everyday objects on the basis of Gaborized outline versions
M Sassi, K Vancleef, B Machilsen, S Panis, J Wagemans (Laboratory of Experimental Psychology, University of Leuven (KU Leuven), Belgium; e-mail: michael.sassi@psy.kuleuven.be)
Using outlines derived from a widely used set of line drawings, we created a large set of stimuli geared towards the investigation of contour integration and texture segmentation in shapes of everyday objects. For each object in the set, we embedded a contour, consisting of Gabor elements positioned and oriented curvilinearly along the object's outline, in a larger field of Gabors, homogeneous in density. We created six di_erent versions of the resulting Gaborized outline stimuli by varying the orientations of elements inside and outside the outline, while keeping the orientations of elements forming the outline itself constant. Data from two experiments, in which we asked observers to identify the objects embedded in the Gabor arrays, provide norms for identifiability and name agreement. Additionally, the results show clear di_erences in average identifiability between stimulus versions, depending on the presence of isolinear textures inside or outside the outline, or both. These stimuli, which we make available through our website, and the accompanying norms provide a useful tool to further investigate contour integration and texture segmentation in both normal and clinical populations, especially when top-down influences on these processes, such as the role of prior knowledge of familiar objects, are of main interest.
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Perceived lightness influences object correspondence
E Hein, C M Moore (Dept of Psychology, University of Iowa, USA;
e-mail: elisabeth-hein@uiowa.edu)
To maintain stable object representations over time the visual system must determine how newly sampled information relates to existing object representations. We asked whether this correspondence process is influenced by the perceived lightness of the stimulus. We used ambiguous apparent motion displays (Ternus displays), in which a set of three adjacent discs were presented in alternation with the same set of discs translated horizontally. The discs could be perceived as moving all together (group motion) or with one 'jumping' from one end of the row to the other while the other discs remain stationary (element motion). Previously, we showed that the relative luminance of the discs could bias observers to perceive either group or element motion, indicating that correspondence was determined at least in part by luminance. Here we distinguished between the influence of luminance and lightness by presenting a transparent filter in front of part of the Ternus display. In the critical condition, lightness values biased group motion and luminance values biased element motion. Observers perceived more group motion in

this condition than when both lightness and luminance biased element motion, indicating that object correspondence was influenced by perceived lightness.
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A role of positional noise in eccentric grouping by proximity
E Poder[1,2] ([1]Institute of Psychology, University of Tartu, Estonia; [2]Laboratory of Experimental Psychology, University of Leuven (KU Leuven), Belgium; e-mail: endel.poder@ut.ee)
Lattices of regularly spaced dots are very simple multi-stable images where the dots can be perceived as grouped in di_erent ways. Kubovy et al (1998 Cognitive Psychology 35 71-98) have suggested a simple quantitative model that predicts probabilities of perception of grouping along di_erent orientations as dependent on distances between dots along these orientations. Bleumers et al (2008 Vision Research 48 179-192) found that, for peripheral presentation, this model should be combined with random guesses on a proportion of trials. The present study shows that the probability of random responses decreases with decreasing ambiguity of stimulus lattice (increasing di_erences between interdot distances along di_erent orientations). Also, bistable and tristable lattices produce di_erent proportions of random responses. With central presentation, adding a positional noise to the dots can produce e_ects that are quite similar to those observed with peripheral presentation. These results suggest that di_erent levels of internal positional noise might explain the main di_erences between peripheral and central proximity grouping.
[Supported by the Estonian Ministry of Education and Research (SF0182717s06) and a research fund of KU Leuven (no. F/07/007)]

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The e_ect of the homogeneity of ground on figure/ground organization
M Takashima[1], T Fujii[2], K Shiina[3] ([1]College of Humanities and Sciences, Nihon University, Japan; [2]Faculty of Economics, Keiai University, Japan; [3]Dept of Psychology, Bunkyo University, Japan; e-mail: psy_experiment@hotmail.com)
The homogeneity of ground is one of the factors in figure–ground organization. We changed texture or color of two profile-areas in 'Rubin's goblet figure'. Observers were asked to describe freely what they perceived. When both profile-areas were gray, observers reported figure–ground reversal. When one profile-area was light gray and the other was dark gray, thus the homogeneity of profile-areas was broken, observers were more likely to perceive profiles (eg 'a man's profile and a woman's profile'). When both profile-areas were filled with horizontal lines, thus the homogeneity of profile-areas was strengthened, observers were more likely to perceive the goblet (eg 'the white goblet in front of a window blind'). These results mean that the figure–ground organization is influenced by the homogeneity of ground.

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Functional aspects of fMRI signal spread in early visual cortex
B Jans[1,2], M Been[1,2], R Goebel[2,3], P De Weerd[1,4] ([1]Dept of Cognitive Neuroscience, Maastricht University, The Netherlands; [2]Maastricht Brain Imaging Center (M-BIC), Maastricht University, The Netherlands; [3]Dept of Neuroimaging and Neuromodeling, Netherlands Institute for Neuroscience, The Netherlands; [4]Donders Institute for Brain, Cognition and Behaviour, Radboud University, The Netherlands; e-mail: bert.jans@maastrichtuniversity.nl)
We measured and modeled fMRI (3T) signal spread in retinotopic visual areas using an unstimulated grey area surrounded by dynamic texture made of randomly positioned line elements of a single orientation, and using a single narrow ring filled with a dynamic black and white texture. Transformation of data in a standard space permitted a parametrical description and modeling of inward spread from texture into the unstimulated region, and outward spread away from the ring representation. We are currently testing whether inward spread into the grey region is larger than would be expected from outward spread away from the ring stimulus. Larger inward spread may reflect subthreshold neural activity from aligned line elements in the texture surround spreading by lateral connections. In addition, we are currently testing the prediction that spread will be anisotropic relative to the orientation of surround line elements, and will increase when grey region and texture surround are presented in conditions that permit perceptual filling-in.
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Influence of attention and memory on formal recognition
S Pescio[1], M L F de Mattiello[1,2] ([1]Laboratorio de Investigaciones Visuales (LIVIS), Universidad de Buenos Aires, Argentina; [2]Laboratorio de Investigaciones Visuales (LIVIS), CONICET, Argentina; e-mail: spescio@fibertel.com.ar)
This study presents a simple experiment that explains the mechanisms of interaction between time, memory and representation. The study was based on an image of medium complexity. This was presented to di_erent observers at variable exposure times: 1 s, which was insu_cient to recognize the stimulus; 2 s, in which recognition occurred 50% corresponding to the least satisfactory limit; 3 s and 4 s, in which recognition was considered satisfactory. In the second experimental session, which occurred after 30 minutes, the partial image was represented. An important result obtained is referred to as 'catastrophic synchronization". In e_ect, one observer was unable to organize characteristics among the various stimuli (Orban et al, 2010 Journal of Vision 10). After fifteen days, the same observers was able to graphically reproduce the stimulus, even when the same was absent. The results confirmed the top-down strategy that helped to complete the elements previously omitted, adding elements that were not present in the initial stimulus (Baylis and Driver, 2001 Nature Neuroscience 4). Finally, the e_ects were analyzed of partially covering the superior, middle, or inferior section of the image. In all cases the proportion of the stimulus was a_ected, however its bilateral symmetry was not. The most obstructive covering came from blocking the superior part of the stimulus, which interrupted border continuity. Based on data presented, one can observe the participation of the inhibiting processes that emerge from competition between the contour and surface regions, especially when opposite sides of an edge are involved (Craft et al, 2007 Journal of Neurophysiology 97).

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Di_erent processing strategies underlie mean orientation discrimination in low and high orientation variance
R Allard, P Cavanagh (Laboratoire Psychologie de la Perception, Université Paris-Descartes, France; e-mail: remy.allard@umontreal.ca)
Discriminating the mean orientation of a set of distinguishable elements is typically assumed to be processed by the same strategy independently of the orientation variance across elements: the observer

averages the estimated orientation of many elements processed in parallel. This assumption predicts similar performance gain in low and high orientation variations as the number of elements increases. We challenged the variance-indi_erence processing assumption by testing this prediction. Either 1 or 4 Gabor patches were briefly presented and their orientations were selected from a distribution that had either no or high variance. Observers were asked to discriminate whether the mean of the distribution was tilted clockwise or counterclockwise from vertical. Increasing the number of elements from 1 to 4 improved performance in high variance but had no significant impact in absence of variance. We conclude that di_erent processing strategies underlie mean orientation discrimination in low and high orientation variance. In high variance, performance depends on the averaging process which follows coarse orientation estimation of many elements. Without variance, the absence of summation suggests that observers are not averaging the estimated orientations of many identical elements presumably because the estimated orientation precision of each element decreases with the number of elements averaged.

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Configural grouping interacts with spatiotemporal and surface feature cues in visual search

S G Havanur, G W Humphreys, H A Allen (School of Psychology, University of Birmingham, UK; e-mail: setu.gh@gmail.com)

Object-based attention has been shown to significantly depend on segmentation and grouping between visual elements. However, research on object persistence suggests that spatiotemporal continuity alone is critical for attention to track across displays. We employed two search tasks which varied spatiotemporal continuity and grouping/segmentation cues in visual search using conjunction and preview stimuli. We varied grouping by manipulating the presence of regular vs irregular displays and whether the displays had common surface features. In addition, continuity was manipulated by introducing a spatial shift across preview and search displays. For preview searches, we found an e_cient search slope for regular trials compared to irregular trials. This finding did not vary as a function of whether surface features were common or changed, or whether spatial continuity was varied (Experiments 1 and 2). Search slope was made e_cient in conjunction search for regular displays only when surface feature grouping was strong (Experiment 2). These results show that maintenance of configural grouping can facilitate

search across displays irrespective of spatiotemporal contiguity. In addition, surface features may guide search in static displays (standard conjunction search). The results suggest that factors underlying object persistence are not independent of grouping cues.

POSTER SESSION: TEMPORAL PROCESSING

m

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Neural timing mechanisms for tactile events

A Tomassini[1], M Gori[1], D C Burr[2], G Sandini[1], M C Morrone[3] ([1]Robotics, Brain & Cognitive Sciences Dept, Istituto Italiano di Tecnologia, Italy; [2]Dipartimento di Psicologia, Università degli Studi Firenze, Italy; [3]Dept of Physiological Sciences, University of Pisa, Italy; e-mail: alice.tomassini@iit.it)

Adaptation studies suggest that visual events are timed by spatially selective mechanisms anchored in real-world rather than retinal coordinates. To test whether this is a general property of event timing we investigated timing mechanisms for touch, using a paradigm similar to that used in vision. After adapting to tactile moving gratings, subjects compared the duration of a test stimulus presented to the adapted hand to a probe presented to the unadapted hand for 600 ms. Adaptation strongly reduced (up to 40%) the apparent duration of subsequently presented tactile stimuli (full adaptation). The e_ect was maintained when the test was presented to a di_erent finger in the same spatial position as the adaptor (spatiotopic adaptation) but disappeared when the test was presented to the same finger moved to a di_erent spatial position (dermotopic adaptation). We also varied the relative and absolute position of the subject and tactile object and found that the e_ect of adaptation was completely cancelled whenever the body moved actively. We suggest that the neural mechanisms for timing tactile events encode temporal information in a body-referenced framework and e_erent motor commands may be of primary importance in constructing and updating a representation within which tactile events are timed.

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Recalibration of audiovisual simultaneity changes detection threshold to sound but not to light

M Di Luca[1], M Barnett-Cowan[2] ([1]Multisensory Perception and Action Lab, Max Planck Institute for Biological Cybernetics, Germany; [2]Dept of Human Perception, Cognition and Action, Max Planck Institute for Biological Cybernetics, Tübingen, Germany; e-mail: max@tuebingen.mpg.de)

Prolonged exposure to asynchronous audiovisual stimulus pairs changes the perception of audiovisual simultaneity. It has been proposed that this change occurs by adjusting the perceptual latency of stimuli in

order to minimize perceived audiovisual asynchrony. How is this adjustment achieved? For signals with a gradual onset, perceptual latency can be minimized by decreasing detection threshold (or vice-versa). Here we assess whether this occurs following recalibration of simultaneity. Participants were exposed for 5 minutes to asynchronous (150 ms) audiovisual stimulus pairs with either light or sound leading. Auditory stimuli were presented via headphones, visual via an LED. Detection thresholds for visual and auditory stimuli were then measured with a 2IFC task interleaved with short re-exposures to the asynchrony. Results indicate that while the detection threshold for visual stimuli does not significantly vary, the detection threshold for auditory stimuli critically depends on which modality leads during asynchronous audiovisual exposure. All nine participants tested were more sensitive in detecting auditory stimuli after light-leading exposure than after sound-leading. We suggest that by becoming more or less sensitive to sound the brain is able to change the perceptual latency of auditory stimuli to minimize audiovisual asynchrony, while keeping the perceptual latency of visual stimuli relatively constant.
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m

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Phantom flashes caused by interactions across visual space

G Chatterjee[1], D A Wu[2], B Sheth[3] ([1]Vision Sciences Lab, Dept of Psychology, Harvard University, USA; [2]Division of Humanities and Social Sciences, California Institute of Technology, USA; [3]Dept of Electrical and Computer Engineering, University of Houston, USA; e-mail: garga@fas.harvard.edu)

Studies regarding contextual e_ects on perception of a visual target's temporal properties have addressed crossmodal integration of auditory context. A deeper understanding of contextual e_ects in temporal vision may be gained by drawing connections with the rich models of signal processing developed in the field of spatial vision. To bridge this gap, we investigate a purely visual version of the crossmodal 'double-flash' illusion [Shams et al, 2000 Nature 408(6814) 788; Wilson and Singer, 1981 Perception and Psychophysics 30(4) 353-356]. Here, a single target flash can be perceived as several flashes when presented in the context of multiple visual inducers. This e_ect is robust across conditions where the

target and inducers are of opposite contrast polarity, in di_erent hemifields, or are non-colinear. The e_ect diminishes when target-inducer distance is increased, or when the target is moved toward the fovea. When the target is foveated, the e_ect can still be recovered if the inducers are placed at 3 degrees distance. Finally, we find that multiple target flashes are not 'merged' into a smaller number of perceived flashes when presented with singular inducers. These results suggest a cortical mechanism based on higher-level event detection. The results also show discrepancies with the cue-integration framework developed in crossmodal studies.

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When simultaneity is more than just temporal order uncertainty

E V Pechenkova[1], M V Sinitsyna[2] ([1]Chair of Academic Psychology, Institute of Psychology (IPP&P), Russia; [2]Laboratory of Industrial Psychology, Institute of Psychology of Russian Academy of Sciences, Russia; e-mail: evpech@gmail.com)

It is still an open question whether perception of simultaneity vs succession is a special process and does not derive from temporal order perception. Evidence for this assumption comes mostly from research in audition [but see Stelmach and Herdman, 1991 JEP:HPP 17(2) 539-550]. Using visual stimuli, we demonstrated dissociation between temporal order uncertainty and perception of simultaneity in two studies. In the first study, the perceptual latency priming paradigm was used. While participants performed either temporal order judgment (TOJ) or simultaneity judgment (SJ) task, one of the targets was preceded by a masked prime in half of the trials. For TOJ task there was a standard shift of point of subjective simultaneity for primed compared to unprimed condition. However, for SJ task in primed, but not in unprimed condition almost no perceived simultaneity was found. In the second study, participants performed two tasks with characters presented in two spatially adjacent and synchronously changing RSVP streams. Under these conditions, we found a range of SOA that resulted in accurate indication of simultaneous items, but very poor temporal order performance. Our results suggest that a possible way to bring forth the di_erence between perceived simultaneity and temporal order uncertainty is manipulation of attentional focus and performance demands.
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m

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Fuzzy scheduling: visual and auditory temporal comparison deficits in developmental dyslexia

P J Benson, L Wallace, S A Beedie (School of Psychology, King's College, University of Aberdeen, UK; e-mail: philip.benson@abdn.ac.uk)

Dyslexia is very common, a_ecting about 25% of school-aged children. If left untreated at an early stage, reading failure can lead to social and mental health problems which may present in early adulthood.

Attention and coordination deficits in dyslexia are also comorbid in ADHD, autism spectrum, dyspraxia and dysphasia. Sensorimotor explanations of dyslexia therefore appeal to impaired development of transient magnosystems in the brain. Young, university-educated adults with confirmed developmental reading disorder (RD) and normal reading (NR) ability judged whether a tone-pair interval was shorter or longer than a reference interval. Response latency and accuracy were impaired in RD compared with NR. The same deficits were found using a visual analogy of the auditory task. These findings were replicated in a second RD and NR cohort. Education and/or learning strategies seem not to have normalised the temporal processing deficit in RD individuals. Diminished sensitivity to temporal information is characteristic of dyslexia. In these experiments, individuals with reading disorder required larger di_erences between temporally-bound sensory events in order to demarcate salient cues from fuzzy auditory and visual representations, benchmarked against a weak or sub-optimally calibrated reference. Results are interpreted within the orthographic and phonological framework of problems experienced in dyslexia.

m

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Flash-lag persists when pre-flash stimulation consists in two reference stimuli approaching and then overlapping each other while post-flash stimulation shows one remaining reference continuing motion

T Bachmann[1,2], E Poder[2], C Murd[1,2] ([1]Institute of Public Law, University of Tartu, Estonia; [2]Institute of Psychology, University of Tartu, Estonia; e-mail: talis.bachmann@ut.ee)

We tested whether flash-lag e_ect (FLE) persists when pre-flash information implies mutually incompatible vectors of motion for the reference stimuli. Two identical reference objects having internal aperture moved along the straight trajectory approaching each other until full spatial overlap was achieved; thereafter, only one reference continued its motion in the same direction while the other was discontinued. A stimulus with its size fitting exactly the inner aperture of the reference was briefly

flashed either before the references overlapped, exactly during the overlap, or shortly after (when only one reference continued its motion). Subjects reported whether the flash was presented before references reached overlap, exactly when they overlapped so that the flash exactly fitted the inner aperture of the reference, or lagging behind the remaining reference-in-motion. In the control condition a standard FLE setup (with only one moving reference) was used. FLE with oppositely moving references had higher temporal value than in the control condition where only one moving reference was used (the di_erence amounted roughly to 60 ms). The results contradicted the metacontrast theory of FLE, suggested several constraints on extrapolation and post-diction theories, and supported object updating and perceptual retouch theories.

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m

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Heterarchical type–token configuration on visual perception

S Tatsumi (Graduate School of Science, Kobe University, Japan; e-mail: 059s455s@stu.kobe-u.ac.jp)

Type–token is a paired concept for representation of cognition, that separates type as an abstract concept from particular instances—tokens. This distinction may be regarded as a universal interpretation in human cognition, like the intent–extent pair. Each of the terms does not predominate for the other (not hierarchy), but has a dynamical influence mutually in an equal horizon (heterarchy). The interface between type/token may be contingent that accepts interaction between two terms of di_erent status not normally comparable. In human face-searching tasks, subjects tend to find human face among non-face stimuli in a significantly shorter reaction time, namely they detect a type-identical stimulus, not the identify of the tokens. In the choice-blindness phenomenon, reasons of choice as a type and a particular face on a picture as a token are reconstructed by each other. In this study, a series of experiment that were designed by mixing those tasks demonstrated the mutual type–token match-up process in visual face recognition. The results suggest that prototypes of types and tokens are constructed temporally and compared directly during observation. Human visual perception is suggested to be a tentative construction of those prototypes, ie models of substance.

m

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Visual stimulus timing precision in Psychtoolbox-3: Tests, pitfalls and solutions

M Kleiner (Dept Human Perception, Cognition and Action, Max Planck Institute for Biological Cybernetics, Tübingen, Germany; e-mail: mario.kleiner@tuebingen.mpg.de)

Visual stimulation paradigms in perception research often require accurate timing for presentation of visual stimuli. Acquisition of exact stimulus update timestamps in realtime is often crucial, both for synchronization of stimulus updates between di_erent presentation modalities and for logging. Modern graphics hardware, multi-core processors and operating systems provide a far higher level of functionality, flexibility, and performance in terms of throughput, than systems a decade ago. They also

pose new challenges for precise presentation timing or timestamping. Typical causes of interference are, eg the dynamic power management of modern graphics cards and computers, novel hybrid graphics solutions, user interface desktop composition and the properties of graphics- and CPU-scheduling of the latest generation of operating systems. This work presents results for the accuracy and robustness of visual presentation timing and timestamping tests, conducted within Psychtoolbox-3 (Kleiner et al, 2007 Perception 36 ECVP Supplement, 14) on di_erent operating systems and graphics cards under realistic stimulus presentation loads. It explains some of the common pitfalls one can encounter when trying to achieve exact timing and some methods to avoid timing problems or reduce their severeness.

m

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Brightness and colour changes of amplitude-modulated flicker used to dissect visual pathways into early and late stages

D Petrova, G B Henning, A Stockman (Institute of Ophthalmology, University College London, UK; e-mail: d.petrova@ucl.ac.uk)

It is well-known that monochromatic lights change colour and/or brightness when flickered; lights near 560 nm, for example, appear brighter, whereas lights near 650 nm appear yellower. These e_ects are usually attributed to nonlinearities, possibly located in di_erent visual pathways. We used the nonlinearities to dissect the temporal characteristics of the two pathways into early (pre-nonlinearity) and late (post-nonlinearity) stages. We used amplitude-modulated flicker with a high carrier frequency (f_c=7.5–50 Hz) and a low amplitude-modulation frequency (f_{am}=0.5–5 Hz). The observer set the modulation threshold for detecting the colour or brightness change at f_{am} either as a function of f_c (to determine the early temporal characteristics) or as a function of f_{am} (to determine the late characteristics). The early characteristics were bandpass for both colour and brightness changes, peaking

at about 10–15 Hz and falling-o_ in sensitivity at both lower and higher frequencies, whereas the late characteristics were low-pass, falling-o_ in sensitivity at higher frequencies with a slope consistent with a one-stage low-pass filter. The early temporal characteristics, which can be related to photoreceptor responses, suggest the nonlinearities are relatively early in the visual pathways. Potentially, these nonlinearities can be used to localize clinical losses in visual function.

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m

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To the temporal dynamics of contextual modulation

M O Goldbach[1], G Meinhardt[1], U Mortensen[2] ([1]Dept of Psychology, Methods Section, University of Mainz, Germany; [2]Psychological Institute, Westfälische Wilhelms-University, Germany; e-mail: goldba@uni-mainz.de)

Perception of primitive visual stimuli is modulated by superimposed and adjacent stimuli. We measured contrast detection thresholds for a foveal Gabor patch masked forward and backward by high contrast Gabor patches, both being pulsed for only one frame. After having determined the optimal facilitatory distance between mask and flanker with stagnant stimulation, we presented mask and target at that distance and modulated their respective onsets.. Synchronous presentation of target and mask caused a strong facilitation of target detection, which is in line with findings from experiments employing stagnant stimuli [Polat and Sagi, 1993 Vision Research 33(7) 993-999; Solomon et al, 1999 Vision Research 39 987-992]. Pulsing the stimuli opposed to stagnant presentation multiplies the mask's facilitating e_ect on target perception for the synchronous condition. Temporal asynchrony in both directions induces a rapid phase transition and the mask's e_ect becomes inhibitory. This observation qualitatively and even almost quantitatively resembles the impulse response of two temporally displaced flashes presented at the same position (Roufs and Blommaert, 1981 Vision Research 21 1203-1221). Di_erent orientation contrasts do not alter the measurement's qualitative result. Our data suggests, that for short stimuli temporal center–surround interaction of adjacent receptive fields shares distinguished features with temporal processing within a single spatial location.

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Time is critical in dorsal contribution for object recognition

F Gonzalez (Universidad Autonoma de Barcelona, Spain; e-mail: fgonzalezperilli@gmail.com)

The dorsal stream for vision is known to be responsible for motor actions control (Milner and Goodale, 1996 The visual brain in action Oxford University Press, Oxford). Research on object recognition has recently established the existence of some degree of a dorsal stream contribution in object recognition (Vainio et al, 2008 Cognition 108 444-465; Borghi et al, 2005 COGSCI2005). The aim of this work is to explore the temporal dynamics of the interaction of dorsal and ventral streams for object categorization. In experiment 1 we run a RT task with 30 subjects who had to indicate if an object was natural or manmade, half of the objects were big and half were small. Three di_erent primings (videos) were presented at the beginning of each trial: a power grasp, a precision grasp and a catch trial. In the trials

in which grasp and object size were congruent, a peak of facilitation was found. In experiment 2 we introduced di_erent SOA conditions (0, 500, 1000 ms) observing a stronger facilitation e_ect at the 500 ms condition. We suggest that time is critical in the interaction of ventral and dorsal paths for vision in object recognition.

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Feature integration but not feature separation can be modulated by TMS

J Rüter[1], T Kammer[2], M H Herzog[1] ([1]Laboratory of Psychophysics, Brain Mind Institute, École Polytechnique Fédérale de Lausanne (EPFL), Switzerland; [2]Laboratory for Transcranial Magnetic Stimulation, University of Ulm, Germany; e-mail: johannes.ruter@epfl.ch)

How the brain integrates visual information across time into coherent percepts is an open question. Here, we investigated this integration using a feature fusion paradigm. In feature fusion, two stimuli are presented in immediate succession. The stimuli are not perceived individually but as one fused stimulus. For example, a left and a right o_set Vernier presented in rapid succession are perceived as one Vernier that is nearly aligned. It has been shown that feature fusion can be modulated by transcranial magnet stimulation (TMS) over the occipital cortex for a surprisingly long duration of 400 ms, showing that neural representations interact for this duration. Here, we show that these Vernier stimuli are perceived individually if separated by interstimulus interval (ISI) of only 20 ms. TMS has no e_ect on the perception of either of the two Verniers. If instead of an ISI a pattern mask is presented for 20 ms, Verniers fuse again and fusion can be modulated by TMS. Our results suggest that TMS can

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a_ect Vernier representations only when features are bound into one object, but not when the very same features belong to di_erent objects.

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POSTER SESSION: VISUAL SEARCH

m

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Conjunction search without target-specific bias: An eye movement study

G M Anderson, D Heinke, G W Humphreys (School of Psychology, University of Birmingham, UK; e-mail: g.m.anderson@bham.ac.uk)

Two experiments examined featural and spatial guidance of attention in a colour-orientation conjunction search. The task required participants to search for two possible conjunctive targets to exclude a targetspecific bias. Experiment 1 showed that, with uneven distractor ratios, search was facilitated and eye movements were directed more accurately to individual items than when the ratio was balanced. In addition, more early saccades were made towards the target in displays with uneven distractor numbers, while saccades to distractors were biased towards those in the smaller subset. Experiment 2 presented balanced distractor ratios but adjacent distractors either di_ered in both colour and orientation or were in two homogenous groups. Unlike with uneven distractor ratios, first saccades tended to fall outside the penumbra of the nearest item, suggesting eye movements were not to specific stimuli, though second saccades corrected this deficit. Response times were shortest when the target di_ered from the local distractor group in the orientation compared with the colour dimension. With homogeneous displays eye movements were initially directed towards stimuli grouped by colour, irrespective of the target's identity. Attention was then guided towards the target by local colour and orientation disparities. The results are discussed in relation to strategies of searching conjunction search displays.

m

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When do faces capture attention? Evidence from eye movements recording

C Devue[1,2], A V Belopolsky[2], J Theeuwes[2] ([1]Centre de Neurosciences Cognitives et Comportementales, Université de Liège, Belgium; [2]Cognitive Psychology, Vrije Universiteit Amsterdam, The Netherlands; e-mail: cdevue@ulg.ac.be)

A recent visual search study showed that the presence of an upright distractor face slows the search for a butterfly target while a butterfly distractor does not a_ect the search for a target face, suggesting that faces capture attention automatically (Langton et al, 2008 Cognition 107 330-342). To further test this hypothesis, we recorded eye movements during a cued target search task. When the search target alternated between a face and a butterfly (Experiment 1), faces were found faster and with less saccades than butterflies. The presence of the opposite distractor (eg a face during a search for a butterfly) slowed down the search but to a greater extent when the distractor was a face. Moreover, faces captured the eyes more frequently than butterflies. Inverted face targets were also found more e_ciently than inverted butterfly targets and captured the eyes more than butterflies when presented as distractors (Experiment 2). However, when upright or inverted faces consistently appeared as irrelevant distractors during a butterfly or a flower target search (Experiment 3), they did not cause significant disruption. These results challenge the view that faces capture attention automatically and suggest that faces only attract attention when their processing is relevant during a search task.

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E Reijnen[1], J Krummenacher[1], Y Kuzmova[2], J M Wolfe[2,3] ([1]Dept of Psychology, University of Fribourg, Switzerland; [2]Visual Attention Lab, Brigham & Women's Hospital, USA; [3]Dept of Ophthalmology, Harvard Medical School, USA; e-mail: ester.reijnen@unifr.ch)
Suppose that you want to direct your attention to the bush with the most raspberries or to the patch of ground with the fewest ants. How e_ectively can numerosity guide attention? In three experiments, observers were presented with arrays of squares (2.7×2.7 degrees) containing small dots (0.2×0.2 degree). They either searched for the target square with the largest number of dots among distractor squares with a smaller number of dots or vice versa (eg, 20 dots among 10 or 10 among 20). Target-todistractor dot ratio is the better predictor of search e_ciency than absolute di_erence in dot number.
In searches for the larger number of dots, ratios of 1.5 or greater yield e_cient search. Search for the smaller number is harder. Ratios must be 0.5 or less to yield e_cient search. For a fixed dot and square size, changes in numerosity produce changes in dot density and total dot area. When square and/or dot size are varied performance declines. Now, search is e_cient only when target-to-distractor ratios are

3:1 or 1:3. As with other guiding features, the numerosity di_erences that can guide attention are much coarser than the di_erences that can be detected in attended stimuli.
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L Caroux, L Le Bigot, N Vibert (Centre de Recherches Cognition et Apprentissage, CNRS - Université Poitiers - Université Tours, France; e-mail: loic.caroux@univ-poitiers.fr)
Many interactive virtual environments such as video games include complex visual displays where various objects are shown superimposed on a moving background. Thus, the main goal of this study was to assess the impact of a moving background, which triggered an optokinetic nystagmus, on visual search for simple objects. A typical visual search paradigm was used. Forty-two participants had to detect the presence/absence of a geometrical shape among 3, 6, or 9 other shapes on a computer screen. The shapes were shown on a patterned visual background (Tozzi et al, 2007 Vision Research 47 861-868) that could either be still or move from right to left at a 12 cm/s velocity. The participants' eye movements were recorded with a Tobii T120 eye tracker. Search accuracy was decreased by the moving background when the target was present in the 9 items condition. However, there was no significant di_erence in response times between the two background conditions. The eye tracking data demonstrated that background movement modified the location of the first eye fixation on the search display, which was located more rightwards than when the background was still. Further research is needed to clarify the impact of moving backgrounds on visual search.

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A I Rätzel, H J Müller, M Zehetleitner (General and Experimental Psychology, Ludwig-Maximilians-Universität München, Germany; e-mail: Isabel.Raetzel@psy.lmu.de)
By parametrically manipulating salience of both feature singleton targets and additional singletons (ASs) in visual search, we found greater interference the larger the di_erence in salience between target and AS was. Surprisingly, also ASs less salient than the target caused considerable interference. Only ASs much less salient than the target failed to interfere with search. This finding challenges current bottom-up theories of selective attention, such as the attentional capture account (Theeuwes, 2010, in press Acta Psychologica), a deterministic model of selection where the most salient stimulus always attracts attention first. Analysis of reaction time distributions revealed that interference was present already in the fastest responses and increased with reaction time latency, independent of ASs salience. This suggests the same process of interference operating for ASs more and less salient than the target. Based on these results, we suggest a probabilistic rather than deterministic explanation for interference in the AS paradigm: target and AS compete for selection the winning probability depending on the di_erence in their respective salience. Accordingly, interference is possible as long as target and AS selection time distributions overlap, even if mean selection times for AS are slower than for the target.
[Supported by DFG Excellence Cluster Grant EC 142 'CoTeSys' to HJM and MZ]

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A Grubert[1], M Indino[2], J Krummenacher[1] ([1]Dept of Psychology, University of Fribourg, Switzerland; [2]Institute of Psychology, University of Zurich, Switzerland; e-mail: anna.grubert@unifr.ch)

In this project addressing the development of selective attention, the visual search paradigm was applied to observers of eight di_erent age groups (six to twenty years) of observers. Participants had to decide whether or not in a multiple item display a singleton target (a single item di_ering from other items) was present and to indicate their decision by a button press. Two search tasks were investigated: singleton feature search, in which the target di_ers from homogeneous distractors in a unique feature and feature conjunction search, in which the target di_ers from heterogeneous distractors in a unique conjunction of features. Search reaction times decreased with age but the decrease in reaction times slowed down with increasing age. Importantly, comparing search times with simple detection reaction times allowed clear di_erentiation of two underlying developmental processes indicated by a purely sensorimotor and a cognitive search time component. Analyses revealed that ongoing sensorimotor maturation (mainly reflected in feature search) underlies shorter reaction times in participants younger than 10, whereas reaction time benefits due to cognitive development (mirrored in conjunction search)

were more pronounced in older participants. Moreover, sensorimotor and cognitive reaction time benefits follow di_erent and seemingly independent temporal trajectories.
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No display, no memory: How a blank display a_ects memory in repeated visual search

C Körner[1], M Höfler[1], I D Gilchrist[2] ([1]Dept of Psychology, University of Graz, Austria; [2]Dept of Experimental Psychology, University of Bristol, UK; e-mail: christof.koerner@uni-graz.at)

When participants search the same 10-letter display in two consecutive searches for di_erent target letters, the time necessary to find the target in the second search depends on when it was fixated in the previous search. This is a short-term memory recency e_ect (Körner and Gilchrist, 2007 Psychonomic Bulletin & Review 14 846-851). The e_ect disappears, when the letters interchange their positions between searches (switch display), while the spatial layout of the display is retained. Curiously, subjects prefer to move their eyes to recently inspected locations where the second target was placed before the display switched. We assumed that the switch is not obvious enough to signal the visual system that a change of the search display had occurred. In the reported experiment, we introduced a short delay with a blank display between the two searches. In the second search, the display was either switched or the same as before (static display). As a result, subjects no longer preferred recently inspected locations in the switched display. In addition, the memory recency e_ect was reduced in the static display. This result shows that the memory mechanism responsible for the recency e_ect can hardly retain the relevant information without continuous visual input.
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Visual search performance in the autism spectrum II: The radial frequency search task with additional segmentation cues

R A Almeida[1], J E Dickinson[1], M T Maybery[1], J C Badcock[2,3], D R Badcock[1] ([1]School of Psychology, University of Western Australia, Australia; [2]School of Psychiatry and Clinical Neurosciences, University of Western Australia, Australia; [3]Centre for Clinical Research in Neuropsychiatry, Graylands Hospital, Australia; e-mail: almeir01@student.uwa.edu.au)

The embedded figures test (EFT) requires rapidly detecting a shape within a complex background. Interestingly, individuals with autism and those high on the autism-spectrum quotient (AQ) are faster and more accurate on this task than typically developing controls. This research is aimed at understanding the visual processes producing this di_erence. Previously we reported performance on a search task using radial frequency (RF) patterns (target RF3, triangle-like shape, amongst distracter RF4s, square-like shapes) with controllable amounts of target/distracter overlap. A high AQ group showed more e_cient search than low AQ observers, as reflected in a shallower gradient for reaction time as a function of set size. Overlapping increased the gradient for both groups, but did not alter their ratio. This study moves closer to the EFT by adding two lines which traverse the display on random paths sometimes intersecting target/distracters, other times passing between them. As with the EFT, these lines segment the display in ways that are task irrelevant. Search was slower for both groups, however the high AQ group retained a consistent search advantage (reflected in a shallower gradient) over the low AQ group. That is, segmentation and grouping created by intersecting lines did not further di_erentiate the groups.
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Hooligan detection: the e_ects of saliency and expert knowledge

D M Endres[1], F Vintila[1], N Bruce[2], J Bouecke[3], P Kornprobst[2], H Neumann[3], M A Giese[1] ([1]Hertie Institute for Clinical Brain Research, Center for Integrative Neuroscience, Tübingen, Germany; [2]NeuroMathComp project team, INRIA Sophia Antipolis, France; [3]Institute of Neural Information Processing, Ulm University, Germany;

e-mail: dominik.endres@klinikum.uni-tuebingen.de)
The detection of security-relevant events in large crowds is a di_cult vision problem. We investigated di_erences in visual search of dangerous events between security experts and naive observers during the observation of large scenes, typically encountered on the grandstand of stadiums during soccer matches. Based on a new algorithm for the synthesis of crowd scenes with well-controlled statistical properties, subjects were eye-tracked during the observation of such scenes. Detection rates, fixation rates and times were assessed from 12 naive subjects and a few expert observers. The results were compared with two theoretical models: (1) an approach for saliency computation based on low-level features (Bruce and Tsotsos, 2009), and (2) a graphical Bayesian model that was trained with expert knowledge derived from scenes containing security-relevant events, exploiting optic flow features extracted with

a neurally plausible algorithm (Beck et al, 2007). We characterize the relative importance of salience and expert knowledge for the generation of correct detections and the visual search strategies for both types of observers. We found substantial di_erences betwen the observer types, suggesting a specific knowledge-driven search strategy for the expert observers.
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A role of hemispheres in the second-order stimuli perception

D V Yavna, V V Babenko, A A Soloviev (Dept of Psychology, Southern Federal University, Russia; e-mail: yavna@fortran.su)
Recently we have shown that visual search is e_ective even if the second-order target is uncertain within one feature dimension and a priori unknown to the observer (Yavna et al, 2009 Perception 38 ECVP Supplement, 55). The present study focused on the properties of evoked brain activity recorded in the course of 4 tests: the visual search for certain (i) first-order target, (ii) second-order target, (iii) the search for uncertain second-order target within one (contrast modulation), and (iv) across three feature dimensions (contrast, orientation, spatial frequency modulations). Both distractors and targets were textures consisting of Gabor patterns. Reaction time was nott dependent on the number of simultaneously visible textures in all tests so search was e_ective. We used the ICA decomposition for EEG source localization [Onton et al, 2005 NeuroImage 27(2) 341-356] and found that uncertainty of target a_ects the lateralization of the evoked activity generators. Therefore, when the second-order target was uncertain, the locus of evoked activity is shifted to the right hemisphere. The e_ciency of visual search for second-order target shows the existence of a mechanisms for detecting the appropriate stimuli. Increasing the search task complexity leads to greater usage of right hemisphere resources.
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Second-order visual mechanisms are fixed filters

V V Babenko, D V Yavna (Dept of Psychology, Southern Federal University, Russia; e-mail: bvv@psyf.rsu.ru)
Some researchers assume that second-order visual mechanisms that combine the local information, operate automatically and independently of higher processing levels. However this hypothesis is not tested yet. To investigate this topic, we used a visual search task where a second-order target is not fixed. In a previous study we investigated a visual search of contrast modulated textures in which the envelope changed from one trial to another. The search was e_ective and parallel (Yavna et al, 2009 Perception 38 ECVP Supplement, 55). This time we used a visual search task where the target texture could not only be contrast modulated, but also orientation and spatial frequency modulated. Both the carrier and the envelope changed from one trial to another. Distractors had the same carrier as the current target, yet they had no envelope. As in the previous study, visual search time did not depend on the number of distractors. This result suggests that second-order visual mechanisms operate as a fixed set of preattentive filters, not modulated by top-down mechanism depending on the task.
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You know where it is before you know it is there: detection and localization in visual search

M Zehetleitner, H J Müller (Dept Psychologie, Ludwig-Maximilians-Universität München, Germany; e-mail: mzehetleitner@psy.lmu.de)
We report faster decision times for localization than for detection of salient feature singletons in visual search. This finding is based on exploiting a geometrical property of random walk decision models, namely, that di_erences in stimulus quality (ie, in drift rates) lead to larger di_erences in observed reaction times (RTs) the longer the decision takes. In two experiments, di_erences in salience arising from manipulations of target/distracter similarity and, respectively, redundancy of the target-defining dimensions yielded larger RT e_ects of salience manipulations for detection than for localization tasks—implying that localization decisions are reached faster than detection decisions. We propose a di_usionbased

model which accounts for the data with one free (nondecision related) parameter between both tasks: the detection decision is achieved by one di_usor triggering a target present or absent response. In the localization task, two detection di_usors, each monitoring one half of the display, race for a left or right response. In summary, the current findings provide a constraint for decision models based on salience signals: localization cannot depend on detection of a target. Furthermore, they open up a way of investigating the interdependence of detection, localization, and identification decisions using RT measures under unlimited viewing conditions.

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